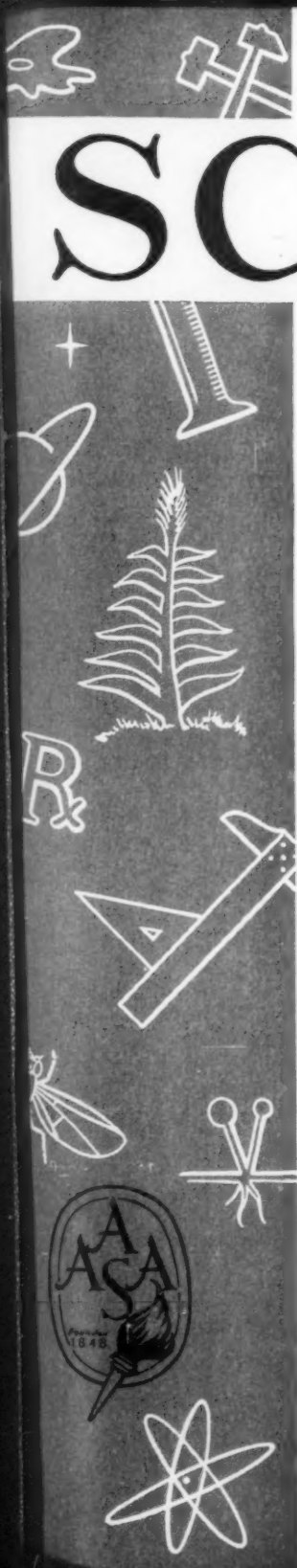

SCIENCE

AUGUST 28, 1953

VOLUME 118 NUMBER 3061

Contents

After Six Years—A Study of the Impact of the Physics Branch Program: *Lawson M. McKenzie* 227

Joseph H. Globus: 1885–1952: *Nicholas A. Michels* 233

News and Notes 234

Technical Papers

Floral-Faunal Associations in American Coal Balls: *S. H. Mamay* and *E. L. Yochelson* 240

Bilateral Interaction in the Lateral Geniculate Body: *P. O. Bishop* and *R. Davis* 241

Stimulation of Rubidium Absorption by Auxins: *N. Higinbotham, H. Latimer,* and *R. Eppley* 243

Some Extensions of Hammett's Equation: *H. H. Jaffé* 246

Electrophoretic Behavior of Acid Phosphatase in Human Prostatic Extracts: *Matthew A. Derow* and *M. Moira Davison* 247

Adrenal Gland Response to Circulatory Distress in Fetal Lambs: *S. R. M. Reynolds* 248

Resolution of Isopropyl Nor-Adrenaline into Optical Isomers and Their Pharmacological Potency Ratio: *E. Beccari, A. Beretta,* and *J. S. Lawendel* 249

Accumulation of Phenylalanine by a Phenylalanineless Mutant of *Escherichia coli*: *Masayuki Katagiri* and *Ryo Sato* 250

Autocatalytic Growth of a Mutant Due to Accumulation of an Unstable Phenylalanine Precursor: *Bernard D. Davis* 251

A Technique for Culturing *Opalina*: *William C. T. Yang* and *Joseph W. Bamberger* 252

Phosphorylation of 3-Methylglucose by Hexokinase from Rat's Intestinal Mucosa: *T. Z. Csáky* 253

Comments and Communications

Hans Bomke; Susumu Hotta; and *Jacob Verduin* 254

Book Reviews

Crime Investigation; Marine Fouling and Its Prevention; Wood Chemistry 256

Scientific Book Register 258

Research in Human Identification 3

Meetings & Conferences 8

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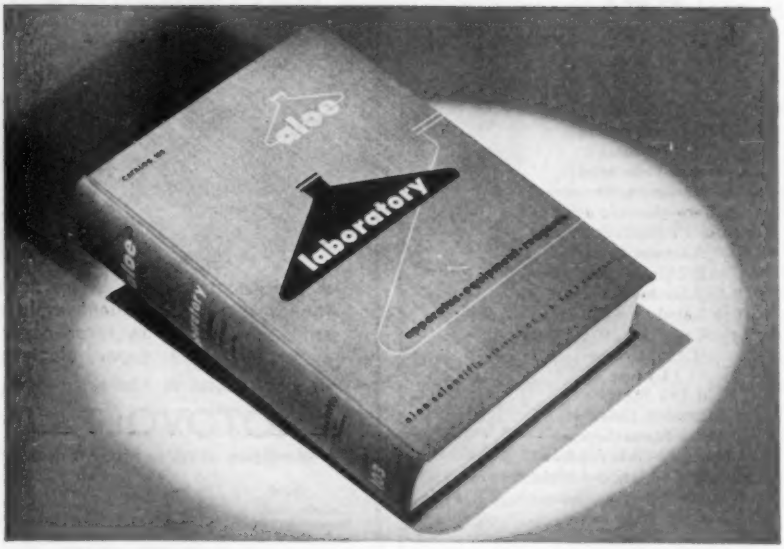

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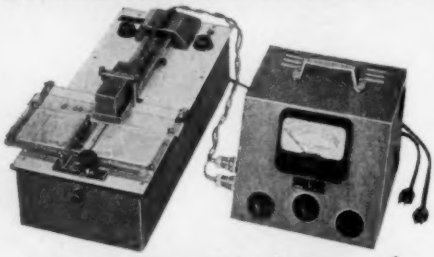

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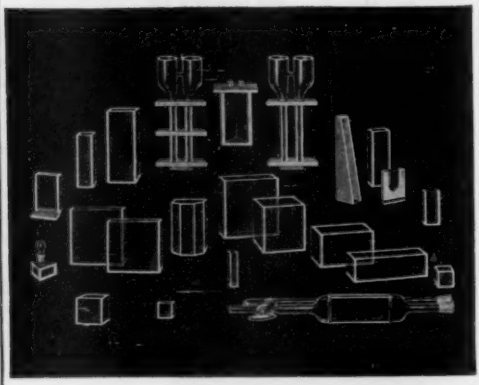

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Research in Human Identification

REMAINS of human bodies, in all stages of decay, are constantly turning up and require the best efforts of the proper authorities to identify them. Natural causes, accidents, suicide, warfare or murder are possible explanations of such deaths. But regardless of what happened to these individuals, they present a common problem which is covered by the question, "Who are they?"

Answers to this question diminish in fullness as the state of decay is advanced or as fewer and fewer parts are recovered. At one end of this range is a freshly dead whole body about which everything in the way of identification—finger prints, blood groups, sex, race, age, and stature—all except perhaps the name, can be stated; at the other end is a minimum representation, say a few pieces of burned bones, which can only be said to be human. At the point in the course of decomposition when soft parts are no longer present or usable, the problem of identification often passes from the medical examiners to the physical anthropologists. Only the physical anthropologists have studied human skeletons from the broad point of view required in identification work.

Strange as it may seem, very little of the information that physical anthropologists use in identifying skeletons was obtained through research aimed directly at medico-legal applications. Such information has been a by-product of basic studies. For instance, out of the use of shadowed collodion replicas of tooth surfaces in routine investigations at the National Institute of Dental Research has come a new means of estimating age from teeth.

Strange, too, the groups utilizing such information in a practical way—law enforcement agencies, the military—have contributed very little to the research involved. For instance, since the close of World War II the Memorial Division of the Armed Forces has had to identify the remains of thousands of soldiers. Yet the military authorities made no plans to profit from this unusual research opportunity. It was largely in spite of military inertia that one physical anthropologist succeeded in improving the formulae for estimating stature from long bones. Now the Memorial Division has wisely substituted these new formulae based on hundreds of American soldiers for those used heretofore, based on 100 elderly French cadavers measured in 1880.

Additional research is needed, especially to improve the estimation of age after skeletal maturation. Present information on this subject comes from the population dregs of large cities which reach the dissecting rooms. These unfortunate individuals have not always given their ages correctly; nor have they led healthy lives. Well-identified skeletons of healthy Americans from the middle period of life are seldom obtainable. This fact emphasizes the unique opportunity afforded by the military reburial program.

It is one thing to estimate age at death, and quite another to verify the age of a living person. The latter problem is coming to the attention of physical anthropologists more and more in connection with immigration and social security operations, and due to the loss of birth records. Lessons learned on the skeleton and brought to bear on the living through roentgenograms can yield satisfactory age determinations. Further research should permit improvement.

Regardless of how far such research is carried, physical anthropology will never reach the state of an exact science. Because humans are naturally variable, physically and developmentally, a certain error of prediction from bones is inescapable. The practical experience that physical anthropologists get in handling skeletal material helps to keep down this error, but right now they can use more information, and that can best be had through well-conceived research.

T. D. STEWART

Division of Physical Anthropology
U. S. National Museum, Washington, D. C.

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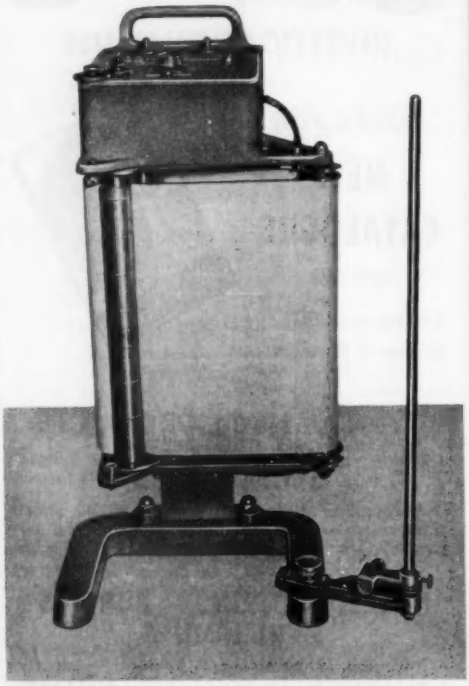

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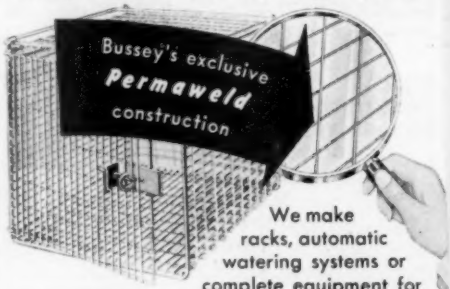

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After Six Years—A Study of the Impact of the Physics Branch Program[1,2]

Lawson M. McKenzie[3]

Physics Branch, Office of Naval Research, Washington, D. C.

DURING the past few months, numerous chief investigators of contracts with the Office were kind enough to give opinions regarding their association with the Physics Branch. Uniformly they lauded the program and its scientific administration. Their criticisms, always constructive, could usually be met if the principles of scientific administration behind Physics Branch policy could be fully implemented (assuming there were sufficient man-hours). It is the purpose of this document to depict the impact of the program and present a brief account of these principles in the light of comments from the contractors. Legal and fiscal issues were also discussed by the investigators. However, since these affect scientific administration only indirectly (although profoundly), they will not be discussed here.

The birth of the physical sciences as we understand them today probably occurred on February 15, 1564. This was the birthday of Galileo Galilei. In 1638, he published his monumental *Dialogues on Two New Sciences,* a treatise that covered much of his life's work. It concerned cohesion and resistance to fracture, and uniform, accelerated, and projectile motion. This served as a basis of the *Principia* published in 1687 by the famous Sir Isaac Newton, who was born the year Galileo died. Newton fully established engineering dynamics in the *Principia,* but the evanescent speculations of Galileo on cohesion and resistance to fracture have not been placed on equal footing. Today we are still wrestling with Galileo's problems, and the hope of placing cohesion and resistance to fracture on a basis as secure as that of mechanics rests in that area of atomistic physics called physics of the solid state. The laws of atomistic physics have been known for only a few decades; they required quantum theory and, particularly, the experimental findings of spectroscopy, as well as the facts that electric, magnetic, and thermal measurements provide.

One area of responsibility for the Physics Branch is solid-state physics. Grounded in atomic physics, this subject seeks to answer questions of the metallurgist, electronics engineer, and other scientists dealing with gross materials. As we see, it reaches back centuries to the work of Galileo for first notice of the problem, but only decades for work upon which to base substantial advances. Heat and cryogenics, electricity and magnetism, radiation and optics are also areas of Physics Branch responsibilities. They too depend upon modern atomistic knowledge for far-reaching advances even though their well-springs are in the works of the ancients. In essence, the central theme of the Branch is recognition of the role played by atomism in the classical divisions of the science. This then is the natural philosophical basis for the program of the Branch. We shall now examine the administrative basis of the program, although we could appeal further to the history of science for examples or go into technical details in support of this philosophy. Our purpose here is to study the impact of the Physics Branch program upon the scientific community and the administrative technique behind it. It is necessary to remember, however, that recognition of the central position of atomism in modern physics permeates all phases of Branch thinking.

As a transition from scientific to administrative philosophy, it should be parenthetically stated that the Branch considers the business of physics to be the reconstruction of facts in thought in abstract quantitative expression of the facts, where the rules which we form for these reconstructions are the laws of physics. Experimental and theoretical techniques are exploited in this process. It is exciting to examine the program in this light and cite accomplishments. Achievement, however, is the purpose of the work under contract, and hundreds of scientific papers contributed by the contractors to the technical journals cover it in detail.

Administratively, the program reflects the profound quality of physics research. It also reflects the sponsoring agency; it is a program with a Navy mission. New scientific facts, of course, are of prime importance to the highly complex and technical Naval situation. Of equal importance are the scientists behind the facts because we constantly appeal to them for special undertakings. We shall examine the program of the Branch to weigh the importance of the scientists and to determine the impact of the program upon the scientific life of the nation.

History of the support of science in the United States proves the program to be a striking development in an evolutionary process. Interplay of government, private, and semiprivate groups is involved.

[1] An article presented at the Conference on Cryogenics, General Electric Research Laboratory, The Knolls, Schenectady, N. Y., October 6–7, 1952, sponsored by the Office of Naval Research and the National Science Foundation.

[2] The views and opinions expressed herein are those of the author and not necessarily those of the Office of Naval Research or of the Department of the Navy.

[3] Executive Secretary of the Interdepartmental Committee on Scientific Research and Development.

In 1789, the first Congress authorized the Navy to conduct experiments for the improvement of ships and guns. This heedfulness to research matters is cited in the splendid study of *Applied Physics in the United States*, edited by Eugene W. Scott (*1*). Attention may also be called to the research-conscious men of our early Navy; in 1816 we note that D. Edward Cutbush, Surgeon of the Navy, became the first President of the Metropolitan Society, a scientific group in Washington. Later he aided in the establishment of the Columbian Institute, a precursor to the Smithsonian. A particular indication of this early interest in science by the Navy appears in a diary note from the *Memoirs of John Quincy Adams* (1827) in which he comments on the remarks made by Samuel L. Southard, then Secretary of the Navy, before the Columbian Institute.

> "... (Mr. Southard spoke) upon the obligation upon the Government of The United States to patronize science. He maintained the cause with great zeal and ability, arguing it as a duty resulting from our situation among the nations of the earth, and recurring specially to the expressed opinions of Washington, Jefferson, and Madison."

Thirty-six years later another Secretary of the Navy, Gideon Wells, appointed a permanent commission of scientific advisors to the Navy; this group later developed into the National Academy of Sciences (*2*).

History also records that in 1830 a Depot of Charts and Instruments was created; this agency was responsible for all chronometers, instruments of reflection, circles, telescopes, and charts, belonging to the Navy. It was the duty of the Depot Officer to inform himself of all improvements and discoveries in connection with navigation. A small observatory for the Depot's use was built on Capitol Hill in 1834, and in 1837 the Depot published its first nautical chart. This agency became the Naval Observatory and Hydrographical Office in 1842 (*3*). The establishment of observatories was not a result of congressional action, although it had the support of friends in Congress, typified by John Adams who "was delighted that an astronomical observatory—not perhaps so great as it should have been—had been smuggled into the number of the institutions of the country, under the mask of a small depot for charts, etc. There was not one word about it in the law" (*4*).

Abraham Flexner has admirably traced the development of the Rockefeller Foundation (1910) indirectly to the Freedman's Bureau, a post-Civil War Federal Bureau created in 1865, and to the private Peabody Fund (1867) (*5*). This pattern is indicative of early interlacing of government and private support; another such example is found in the history of the Research Corporation (1912). Frederick Gardner Cottrell wished to assign his patents to establish this magnificent grants-in-aid program to the Smithsonian Institution, but this method met with certain difficulty and the Corporation was established (*6*). The purposes and practices of the Rockefeller Foundation and the Research Corporation are well known, and their impact upon the American scene of scientific laboratory development is without equal except in extent of support. Direct government aid through the Office of Naval Research simply multiplies manyfold the available funds to carry American science to new heights in the traditional manner.

The initial task of the Physics Branch, Office of Naval Research, then Office of Research and Inventions, was contracted with the Carnegie Institute of Technology on March 1, 1946. The Task Order concerned research on plastic deformation of solids and was conducted by James S. Koehler and his students. Three other contracts, also concerned with solid-state physics research, were made that day at Carnegie Institute of Technology, Johns Hopkins University, and Cornell University. These particular tasks have terminated.

Two new tasks were subsequently initiated and directed by the two investigators at Carnegie Institute of Technology, but they are now members of the University of Illinois faculty. These tasks evidence continuity with the earlier work although, of course, they reflect the nature of the new environment. The researches formerly sponsored under the Johns Hopkins and Cornell contracts are today being continued under the sponsorship of other agencies and must, therefore, meet the program requirements of these agencies.

About one-half of the program consists of long-lived tasks; the others are shortly to be completed or supported elsewhere. Of course, immediately after World War II, the Office was virtually alone among the sponsors of basic research. A few years later, the Atomic Energy Commission began to build its program. Today, the Office of Ordnance Research, the Office of Scientific Research of the Air Force Research and Development Command, the National Science Foundation, and other agencies are sponsoring research on a project basis. With rising costs, an enlarging scientific community, and a fixed budget (the budget of the Physics Branch has remained at substantially a constant level for 5 years), such diffusion is the only mechanism to meet the new demands for necessary researches in physics. The Physics Branch welcomes these new sponsoring agencies as an aid in removing the dilemma, although the problem of multiple-sponsorship of the various programs raises new problems of scientific administration. In effect, the Branch serves the new agencies in a working capacity.

The Branch supports physics not only financially but also administratively. It is by the latter that the scientific personnel of the Branch contribute to progress of their science. A scientist in the Branch may do original research apart from his ONR duties, but his principal contribution to physics is through his function as a scientific administrator. He serves as a clearing house of scientific findings, he initiates symposia, he indicates research progress to groups in authority for the purpose of securing funds. But he is

not alone; his function as an administrator is in close association with the research scientist.

This association of research scientist and scientific administrator has been of a grass-roots variety. For example, Robert J. Maurer, Chief Investigator of the Carnegie Institute of Technology contract, served as a Head of the Physics Branch. This is a particularly striking instance of the close association between the investigators under contract and the scientists of the Office. It is typical of their immediate contribution to the general program in conjunction with their equally important but far more obvious contribution through the specific research contract with the Office. It is through such relationships that the technical needs of the Navy are anticipated with vigor and effectiveness. Such factors are deemed by Branch members to contribute substantially to the strength of the program.

The contractors are not the sole source of the research scientists who have come to assist the Branch. Elliott W. Montroll, who succeeded Professor Maurer, is typical. Of course, the research scientists do not necessarily spend full time with the Office when on leave of absence from their laboratories. The Branch is fortunate in having a group of consultants who contribute to the program on a daily basis as required. Professor Maurer, for example, recently undertook a two-week study. His report is the basis for a new research and development effort that will probably be carried out at the Naval Research Laboratory by two scientists who were incidentally trained by Dr. Maurer. It should be mentioned that they received their Ph.D. degrees while working on the Carnegie Institute of Technology contract named above. Note the direct values received over and above the research contracted for at Carnegie: Maurer's direct association with ONR, and two students who obtained their Ph.D. degrees now employed at NRL.

The grass-roots basis of the program is but an indication that every effort is made to administer the program along sound lines. The administrative devices are the accepted ones in normal executive practice. It should be understood that there is nothing unique about the management of the Branch unless it is the fact that circumstances have provided a large measure of the desirable factors in its control system, and these are commonly recognized as desirable in management of any enterprise, for example, a research laboratory. These factors are nicely catalogued in an excellent book by Robert N. Anthony (*7*) and in the more theoretical and general treatment of Chester I. Barnard (*8*).

The Branch consists of Sections which are fairly stable organizational units, and they work in such concert that the program is always considered as a whole. Remembering that atomistic physics permeates the whole, the sectional division into four phenomenological areas, optics, heat, electricity, and magnetism, centers attention on areas in which the Navy's interest appears. Each topic is given essentially equal weight and organizationally these are the principal sections.

The Branch recognizes instrumentation as a science; there is also a small effort in this line to direct the fruits of novel gadgets gleaned from the program as a whole into appropriate channels. Such dividends are mainly unforeseen. This small program is the nearest the Branch comes to development although considerable foundational research is undertaken in the main areas of responsibility. By and large, the program is basic in character although the Scott document (*1*) would by definition include some of the most basic work as applied, since a Navy need exists and the work is purposefully sponsored.

To point out an example, let us consider one program which has been particularly rewarding. The subject of extremely low-temperature physics has been given principal attention in the Section on heat. Research in this area has always been considered essentially basic. Where is the Navy mission?

Properties of matter at low temperatures, when unobscured by thermal fluctuations, are important to a myriad of technical applications. A lower limit is set by nature in the case of detector elements of great sensitivity unless they are protected from sources of energy that alter their properties. Reduction of thermal fluctuation can be accomplished by cryogenic research. Control mechanisms and communications systems are obvious areas of benefit since noise reduction is the one sure means of maintaining the purity of the information being transmitted.

Extremely sensitive bolometers, the photoconductors, and crystalline electronic components are elements of Navy gear currently being engineered for low-temperature use. Superconductivity, a phenomenon peculiar to certain substances, including lead, tin, and mercury, appears only below a definitive very low temperature and at a specific magnetic-field strength. These very properties offer means to construct bolometers and magnetometers of high sensitivity and low noise. Perfect magnetic shielding is also available through the use of superconductors that thus provide means of excluding magnetic noise in the atmosphere from a space within a shield. High-Q resonators are available in the form of cavities fabricated from superconducting material. Q's of the order of millions have been reached. These are obvious areas with a Navy mission, and equally so is the insulator that becomes so perfect at low temperatures that charges are held for very long times, thus providing means of storing information. Here are uses with naval significance.

The Navy mission of basic research is generally quite obvious in the case of photoconduction, luminescence, semiconductor research, and work on para- and ferromagnetism. Military infrared, crystal rectifiers and amplifiers, and magnetic and electromagnetic gear require such research. There is scarcely an area of pure research for which a need does not exist in the formable technical enterprise that is the Navy. An even

greater need exists for the trained minds and hands that are developed in the course of research carried out in our university laboratories.

The Director's Report of the American Institute of Physics (*9*) for 1951 states: ". . . it appears that 46% of physicists today are employed by educational institutions, 36% by industries, 15% by the Federal Government and the rest by nonprofit laboratories, health services, etc." Data from forty-eight Physics Branch contractors, chosen at random, give an interesting account of the distribution of their best graduates holding Ph.D. degrees. Of 549 men trained in these ONR programs, about 280 obtained the Ph.D. About half were listed as particularly outstanding, and the distribution of 198 is as follows:

Government laboratories	
Atomic Energy	18
Navy	14
BuStandards	4
Air Forces	6
	42 or 21%
Universities	66 or 33%
Industrial	
DuPont	7
Gen. Electric	16
Westinghouse	6
Aircraft indust.	9
BTL	5
RCA	4
Research instit.	9
Other	24
	80 or 40%
Foreign	10 or 6%

The importance of all these men to the Navy is clear since scientists in the industrial and academic research groups contribute almost as directly to our technical enterprise as do those in Navy laboratories.

Navy mission is one factor in considering a task for support by the Branch. The prime factor is, of course, scientific excellence. In addition to these, many factors must be considered in building the program (*10*).

1. Value of research problem
   - (a) In view of overall program
   - (b) Navy interest
   - (c) Concentration of effort in the field
     - (i) Gaps in effort
     - (ii) Support of borderline fields (viz., biological)
   - (d) Timeliness
     - (i) Acceleration factors
   - (e) Chance of striking discovery
2. Cost
3. Record of principal investigator (and associates)
4. Participation of institution
   - (a) Financial or equivalent
   - (b) Special facilities
5. Training of personnel
6. Stimulus to national research
   - (a) Small institutions
7. Geographic distribution
8. Requested work by bureaus, Department of Defense, or other governmental agencies
9. Availability of laboratory equipment
10. Amount of money or number of tasks presently under way
11. Work load of chief investigator
12. Probability of successful completion
13. Possibility of other sources of support
14. Limit on term of project

This list does not presume to indicate order of emphasis. Although the principal criteria are necessarily the scientific value of the proposed research project, it may be of less importance when considered in connection with the other points. A few details may make the meaning clear. An important problem proposed without backing of facilities or personnel obviously lacks merit. Less obvious is the relatively important position of an adequate but minor research proposal at an institution lacking national prominence, but sponsored by a sound man with only modest facilities. The problem may be very minor indeed if a research contract is undertaken at a place where the research tradition is wanting and particularly if new research workers have to be trained.

Contrariwise, one item of considerable importance that tends to offset emphasis upon support of admittedly important work at accepted research institutions is the contribution of the contractor to the research program. It is usually a definite part of university activity to require the production of research papers by faculty members. This is a recognized faculty duty, and personal advancement is weighted by this activity. The university budgets allow for this research. The Branch seeks to accelerate and intensify such activity, but not to substitute for the university in meeting this responsibility. Participation of the institution in whatever basic work is undertaken is thus an important criterion. With respect to cost, it is perhaps selfevident that a balance between scientific value and money available must assure maximum usefulness of money spent. It is felt that the preceding list contains the most important clues to the procedures necessary for accomplishing this desired state.

Reference to the January 1952 House hearings on the National Science Foundation 1953 Appropriation Bill shows that these are the same rules of practice followed by the National Science Foundation in awarding grants-in-aid. Their list is in fact: (1) scientific merit, (2) competence, (3) institution backing, (4) budget soundness, (5) evaluation as to current research in area, (6) government interest, (7) contribution to over-all program, and (8) cost in relation to available budget.

In the hearings we read also that "while research work is neither controlled nor directed by NSF, careful administrative controls are maintained over the expenditure of all funds." Five items that are involved in the control process are: (1) payment quarterly, semiannually, or annually, (2) progress reports reviewed, (3) financial reports reviewed, (4) visits "to check the accounting for the work," (5) funds revert to NSF.

We have dwelled upon the specific deliberations of scientists within the Branch in controlling its program, and we have seen that this is also a policy of NSF. It is wise at this point, therefore, to prescribe fully the nature of this technical guidance for the purpose of avoiding any misapprehension of the role of the Branch administrator. In his association with a contractor, he is the "Scientific Officer," the responsible agent of ONR, and he is formally charged with supervision of the project. The word "supervision" is used rather than "direction," for direction often is used in a sense of "command." First of all, project supervision does not mean regulation of the course or conduct of the research contracted. It has even been suggested that the prefix "super" be eliminated to better understand the attention given by a project scientific officer to the particulars of a project. Of course, this is not a unique situation. C. E. K. Mees (*11*), in *The Path of Science,* has quoted at length the warnings of prominent directors of research with regard to the stultifying action of attempting to direct research either by a director or a supervisory board.

The principal power in the hands of the ONR scientific officer is his influence in awarding and terminating contracts. It is an important device; responsibility in using it is not light, nor is its effectiveness trivial in contributing to scientific progress. He must determine the merits of a possible project by review of proposals, by visits to laboratories, by scientific conversations with investigators, and by consultations with specialists. In terms of a research program and status of the budget, he must then determine whether or not to recommend the award of a contract. After a contract has been in force, he must use the same means, together with vision of the probable outcome of the investigation, to determine whether to extend or terminate the contract. These actions, of course, are taken in accordance with the general doctrine of the Office of Naval Research.

It must be re-emphasized that the Branch scientific officer is principally a scientist, although in most cases he is not a specialist in the same sense as the investigator whose work is under his cognizance. But by his breadth of experience, this officer serves as a valuable link between extreme specialties. He plays an unusual role, therefore, in the scene of scientific communication. The contractors have themselves expressed a need for such information. This is a very active part indeed in the particular research program he supervises.

One function of his office is to create a tie between projects, thus bringing them together into a well-organized program. It is by no means an invisible tie. He has a power to call conferences of the contractor's representatives and thus create small, intensive, ad hoc scientific societies for the mutual benefit of the investigations under way. This serves to avoid duplication and to swiftly pass along advances as they are made. It also serves to inform scientists of naval problems and weds the program, not only by fusion to itself but also by diffusion, to the broader program of the ONR, the Navy, and Defense Research. The conferences called by the Branch have the enthusiastic support of the contractors.

He controls details of the budget of the project. Travel authorization is one important example. As Bernal (*12*) has said, "It is a common experience in visiting laboratories to notice at the same time unsuspected improvements which have been in use for years and obsolete techniques which have survived for as long a period. To carry on with obsolete methods may often lead to the waste of years of effort, but this waste is inevitable unless much more rapid and direct personal means of communication between scientific workers is effectively organized." The power of travel authorization in the hands of the project supervisor is thus a major device with which he may enhance the efficiency of a program. He must use it wisely for its abuse may jeopardize his control of it.

Still another consideration is the approval of expenditures for items costing more than a certain sum. One of several theories for support of basic research does not allow purchase of capital equipment, but does require the money to be spent on scientific personnel (i.e., brains). Thus, approvals of large expenditures on equipment abridge this rule. Indeed, examples can be cited to show the appropriateness for authorizing such expenditures and the consequent benefits to the progress of the program. Such are the paradoxes that daily must be resolved by the scientific administrator.

Mees (*11*) remarked, "The administrators and organizers of society have been trained chiefly in the humanities and are largely ignorant not only of the facts of science but of the scientific method. The scientists, on the other hand, are absorbed in their own problems and too often have little time to spare for (the humanities). . . . The humanists must understand what the scientists have done in the past, are doing now, and may do in the future; while the scientists must see their work in the light of history and in relation to the effects that its application to social conditions will produce."

The scientific officer effects this necessary liaison between research and purely administrative functions. He must satisfy the fiscal officer's wariness of "boondoggling" in the latter's ultimate accounting procedures by demonstrating to him that true value can be obtained through authorization of unusual expenditures, for example, the rule of government publication policy. Such matters are often puzzling concepts to scientists unaware of government policies and the way in which the government works. It is the role of the scientific administrator to bridge this gap.

C. I. Barnard (*8, 13*), the president of the Rockefeller Foundation, indicates that intuition plays a primary role in the successful function of the executive. One frequently hears science program administrators say that they must "play by ear" to arrive at decisions. This is but another way of stressing the

fact that intuition must be highly developed in this class of scientific personnel. Intuition development is not a mysterious process; it certainly is not second sight. It represents the sum of the experiences of the scientist and, when he acts as an administrator, his experiences from an interaction with many segments of society. The success of a scientific officer does not rest upon his meritorious performance as a research scientist alone—he also must have either the necessary humanistic background or genuine desire to put aside full-time research long enough to cultivate it.

The Physics Branch scientific administrators and their advisors and committees strive to build not only a strong program of basic physics, but also to apply the basic program to its Navy mission. The present program in basic research has resulted from years of work by the Branch, and it is the reservoir that is feeding an applied program administered by the Branch and sponsored broadly throughout ONR and the Navy.

It is obvious that the program depends upon the scientist acting as an administrator; as a corollary, this is a requirement for a grass-roots program. The business administrator is unfit for this role. Yet in the excellent book of Anthony (*7*) we find this point misunderstood. We should not go to the opposite extreme, for the business executive certainly has a role that is recognized by the Branch scientific administrator as vital to the program.

Anthony states, "The research worker typically does not understand or care much about the problems which confront the management of a laboratory. In general, he believes that these problems are less important than the specific technical problems on which he is working, although out of politeness he frequently will not say so. In the course of our investigation, we hear administrators and administrative functions described in terms which cannot be printed here" (*14*). Anthony also declared, "Formal communication (i.e., paper work) is generally disliked by everyone, and especially by technical personnel" (*15*). However, it is difficult to determine his meaning unless it is to influence the reader who is also urged to doubt the validity of the opinion that "Scientists and engineers are almost unanimously of the opinion that the head of a research organization must be technically trained and technically competent" (*16*).

The role of the scientific administrator finds its complete expression in the administrative controls of ONR. To repeat, this is recognized by the Physics Branch as the essence of its program. It is hoped that this exposition will help those interested to appreciate the function of the scientist in the Physics Branch program of atomistic physics research. The methods of administration have been lauded in many letters from contractors to the Branch. They uniformly express the opinion that this is a most important feature of the program to them.

Although this analysis is specific to the administration of the program of the Physics Branch, it is perhaps not too presumptuous to speculate that the same analysis may be directed more generally. In the Sixth Annual Arthur Dehon Little Memorial Lecture at MIT, Sir Henry Tizard (*17*) casts the role of the scientific administrator in the broad role of service in our free democratic society. He stated: "I hold that if science is to have a real influence on national policy, some scientists must be prepared to spend part of their lives in the closest daily touch with men who formulate the policy. It is not necessary that they should be the best scientists, so long as they enjoy a reasonable measure of the confidence of more gifted colleagues, and do not retreat too far from the advancing tide of science."

References

1. Scott, E. W., Ed. *Applied Research in the United States*, Natl. Acad. Sci., Nat. Research Council, Washington, D. C., 9 (1952).
2. True, F. W., Ed. *A History of the First Half Century of the National Academy of Sciences*. Washington, D. C.: Natl. Research Council (1913).
3. Petze, C. L., Jr. *The Evolution of Celestial Navigation*. New York: Motor Boating, 34 (1948).
4. *Congressional Globe*, 738, April 28, 1846.
5. Flexner, A., and Bailey, E. S. *Funds and Foundations*. New York: Harper (1952).
6. Cameron, F., and Cottrell, F. G. *Samaritan of Science*. New York: Doubleday, 148 (1952).
7. Anthony, R. N. *Management Controls in Industrial Research Organizations*. Cambridge: Harvard Univ. Press (1952).
8. Barnard, C. I. *The Functions of the Executive*. Cambridge: Harvard Univ. Press (1935).
9. *Physics Today*, 6, May (1952).
10. Annual Report of the Physics Branch (1949).
11. Mees, C. E. K., and Baker, J. R. *Path of Science*. New York: Wiley, 198 (1946).
12. Bernal, J. D. *The Social Function of Science*. London: Macmillan, 119 (1939).
13. Barnard, C. I. *Mind in Everyday Affairs*, Guild of Brackett Lectures (1936).
14. Anthony, R. N. *Op. cit.*, 57.
15. *Ibid.*, 126.
16. *Ibid.*, 31.
17. Tizard, H. *Science and Democracy*. Cambridge, Mass.: A. D. Little, 22 (1951).

Joseph H. Globus: 1885–1952

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Joseph H. Globus died suddenly on November 19, 1952. He had been associated with New York University for sixteen years, as assistant professor of neuroanatomy from 1923 to 1927 and as assistant professor of neuroanatomy and neuropathology from 1927 to 1939; he had been assistant clinical professor at Columbia University from 1937; he founded and edited the *Journal of the Mount Sinai Hospital, New York,* in 1934 and the *Journal of Neuropathology and Experimental Neurology* in 1942.

Dr. Globus served as president of the American Association of Neuropathologists, as president of the New York Neurological Society, and as chairman of the Section of Neurology and Psychiatry at the New York Academy of Medicine. Over thirty years of his professional life as neurologist and neuropathologist were devoted to Mt. Sinai Hospital. His investigations on the histogenesis of brain tumors were so profound and original that his correspondence with Harvey Cushing regarding a system of classification of brain tumors grew to voluminous proportions (to be published later) and ultimately culminated in world-wide adoption of the system he proposed.

Dr. Globus was born in Vitebsk, Russia, on November 25, 1885, the grandson of a well-known physician. At the age of 20 he emigrated to the United States where he quickly learned and mastered the English language. He received his B.A. degree from Columbia College in 1915 and his M.D. degree from Cornell University in 1917. His internship was served at Montefiore Hospital (1917–18) and was followed by training in psychiatry at Manhattan State Hospital. In World War I he served his country as a first lieutenant in the Army Medical Corps. As a Blumenthal Fellow in 1920 he went to Germany where he received further fundamental training in neuroanatomy and neuropathology under men of the Jakob and Alzheimer school. While there, he met and married Grete Gans who bore him three children.

Upon his return to the United States, Dr. Globus resumed his activities at Mt. Sinai Hospital and received the following well-merited appointments: assistant neuropathologist (1921–28); associate neuropathologist (1928–39); and neuropathologist (1939–51). After his official retirement he served as consultant neurologist and neuropathologist.

Prolonged association with Dr. Globus in research work, in his activities in neurological wards, coupled with visits to his home, allowed me a full measure of the man as teacher, scientist, physician, and family man. As a teacher, Dr. Globus was eminently successful and highly respected. Without affectation he held the attention of his students and inspired independence and self-reliance in them. It was with this purpose in mind that his well-known textbook *Neuroanatomy,* with incompletely labeled illustrations, was written.

The carefully prepared, creative contributions of Dr. Globus on the morbid anatomy of the central nervous system number more than 100. They comprise such diverse subjects as the histogenesis of leptomeningeal and pachymeningiomatous tumors, spongioblastoma multiforme, multiple sclerosis and internal hydrocephalus, pinealoma, infundibuloma, teratoid cysts of the hypophysis, tumors affecting the optic chiasma and optic tract, amaurosis, cerebral aneurysms, massive cerebral hemorrhage, brain tumors of children, primary melanoblastosis, chorea, and the origin of the so-called round cell infiltrations in poliomyelitis and encephalitis.

As a physician Dr. Globus was efficient, practical, considerate, and sagacious. Fearlessly close to the stark realities of life, he was always optimistic and cheerful. His habits of interspersing conversation with philosophical truisms, medical anecdotes, and witty remarks endeared him to his colleagues and subordinates and engendered in them a respect for truth and ethical procedure. His kindheartedness and deeply sympathetic attitude reflected the magnanimity of his soul and accounted for the special care and consideration he graciously extended to the indigent old men and women in the neurological wards entrusted to his care. The strains on his heartstrings were many, the greatest and tenderest being the welfare and happiness of his beloved wife and cherished children.

The achievements of the scientist and physician Globus will always be a striking example of the lofty medical heights a man of foreign birth and meager financial circumstances may, through altruistic endeavor and scientific accomplishment, attain in the free democracy that is ours in the United States. Benefited by his life of self-sacrifice and service, we may assuage our bereavement in his untimely death and leave to posterity, as did Alzheimer and Cajal, the cherished memory of his manifold and ideal accomplishments in his chosen field of work.

News and Notes

Conference on the Use of Tritium in Organic and Biological Chemistry

In order to facilitate the exchange of information among scientists engaged in research involving tritium, the radioactive isotope of hydrogen, a conference, sponsored by the Argonne National Laboratory, was held at the Laboratory on June 19, 1953. This conference, the first to deal exclusively with the use of tritium in chemical and biological research, was organized by Dr. A. R. Van Dyken and was attended by 70 scientists representing 35 laboratories in the United States and one in Canada.

The conference, introduced by Dr. J. C. Boyce, Associate Laboratory Director, was held in two sessions. The morning session, devoted to the determination of tritium, was presided over by Professor W. G. Brown of the University of Chicago. Dr. K. E. Wilzbach of Argonne National Laboratory discussed the determination of tritium in organic compounds by ion current measurements. Dr. F. N. Hayes of Los Alamos Scientific Laboratory described the scintillation counting of tritium compounds. The absolute beta counting of tritium was discussed by Dr. R. C. Hawkings of the Chalk River Project, Atomic Energy of Canada Limited, who would welcome requests for samples of tritium water for intercomparison by laboratories doing absolute counting. Dr. A. A. Benson of the University of California spoke on the paper chromatography of tritiated intermediates of photosynthesis. Extended remarks were added at the conclusion of several of the invited papers. Dr. V. P. Guinn of the Shell Development Company described ion current measurements at his laboratory, Dr. D. E. Beischer of U. S. Naval School of Aviation Medicine, Pensacola, discussed radioautography of monolayers, and Dr. H. L. Bradlow of Sloan-Kettering Institute for Cancer Research discussed solid counting.

The afternoon session, with Dr. Van Dyken presiding, was concerned with chemical problems encountered in the use of tritium. Dr. A. R. Ronzio of Los Alamos Scientific Laboratory described the procedures used in the synthesis of tritium compounds, particularly at high concentrations. Dr. D. K. Fukushima of Sloan-Kettering presented the results of studies of the platinum-catalyzed exchange of hydrogen isotopes with steroids. The isotopic fractionation encountered in the use of tritium in chemical systems was discussed by Dr. L. Kaplan of Argonne, and Dr. M. L. Eidinoff described the determination of isotope effects in some biological systems.

A. R. Van Dyken
K. E. Wilzbach
L. Kaplan

Argonne National Laboratory

A Summer Conference in Collegiate Mathematics

A Summer Conference in Collegiate Mathematics was held at the University of Colorado from June 15 to August 8. The National Science Foundation first made the suggestion that such a conference be held. The Committee on Regional Development of the National Research Council made the preliminary plans, including designation of location and objectives; and the National Science Foundation granted financial support.

The primary object of the Conference was to assist teachers in colleges and universities not closely associated with the big research centers to improve the quality and quantity of undergraduate majors in mathematics; this to be accomplished by giving such teachers an opportunity to think and to discuss mathematics under the guidance of men who are not only nationally known, but who can give to non-specialists clear and inspiring pictures of the sweep and depths of present-day mathematics.

During the Conference, Professor Emil Artin of Princeton University lectured on "Modern Developments in Algebra" and Professor Raymond L. Wilder of the University of Michigan on "Foundations of Analysis and Geometry." Other lectures were Professor George Polya of Stanford University, who discussed "Great and Small Examples of Problem Solving"; Professor E. P. Northrup of the University of Chicago discussed "Elements of Mathematics from a Modern Standpoint"; and Dr. Carroll V. Newsom, Associate Commissioner of the University of the State of New York, considered the "Appraisal of the Undergraduate Curriculum in Mathematics." In addition to the regularly scheduled lectures, various persons travelling through Boulder kindly consented to talk to the group. The notes of the lectures were compiled by assistants and reproduced for members of the Conference.

The grant of the National Science Foundation not only provided for salaries of lecturers but included funds to provide stipends for 21 members. The University of Colorado assumed part of the cost of secretarial help, costs of dispensing the funds, and allied expenses.

In addition to the scheduled program, an informal group was formed to consider curriculum problems and to permit interchange of information on undergraduate programs at various institutions represented. Since most of the members of the Conference lived and had their meals in one of the residence halls of the University, there was ample opportunity for becoming acquainted and comparing notes on mathematics and teaching problems.

It is hoped that the success of this Summer Conference will result in similar national conferences being held in other localities in the future.

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Dr. Bronk Assumes New Post

Detlev W. Bronk, sixth president of The Johns Hopkins University, announced his resignation June 24 to become president of the Rockefeller Institute for Medical Research following a merger of the Institute's Board of Trustees and Board of Scientific Directors into a single Board of Trustees. **Herbert S. Gasser,** who is retiring as director of the Institute, a position that he has held since 1935, will be succeeded by **Thomas M. Rivers.** Both men are graduates of The Johns Hopkins University School of Medicine. Dr. Gasser, who, with Joseph Erlanger, was awarded the Nobel Prize in 1944 for research in the physiology of nerve fibers, will become member emeritus and continue his scientific work at the Institute. Dr. Rivers first became associated with the Institute in 1922, and has been director of the Rockefeller Hospital since 1937.

Dr. Bronk became president of The Johns Hopkins University on January 1, 1949, succeeding the late Isaiah Bowman. He is the author of the Hopkins plan, a program announced in 1951, which is designed to erase the long-standing barriers between undergraduate and graduate study, enabling students to progress at their own speed.

Dr. Bronk is chairman of the board of directors of the American Association for the Advancement of Science and president of the National Academy of Sciences. Upon accepting the latter honor in 1950, he resigned the chairmanship of the National Research Council, a post he held for four years. He was appointed by President Truman to the executive committee of the National Science Foundation, which was organized in 1950 to advise the Federal Government on defense problems.

Born in New York City on August 13, 1897, Dr. Bronk received his A.B. degree from Swarthmore College in 1920. While still an undergraduate he served as a naval aviator in World War I, later spending a short period as assistant power engineer of the Philadelphia Electric Company and as instructor of physics at the University of Pennsylvania. His scientific career began in 1921, when, as a graduate student and physics instructor at the University of Michigan, he and two others published a paper that is a classic in infrared spectroscopy and which gave rise to the theory of half quantum numbers. After receiving his M.S. degree at Michigan, he became interested in physiology and earned his Ph.D. in both physics and physiology. In 1926 Dr. Bronk went to England, where he studied the heat produced by muscle. He and E. D. Adrian of Cambridge University were the first to record electrical activity in single nerve fibers, opening an entirely new field of neurophysiology.

Upon his return to the U.S., he became professor of biophysics and director of the Eldridge Reeves Johnson Foundation at the University of Pennsylvania, then joined The Johns Hopkins University as president in 1949. Holder of 15 honorary degrees, Dr. Bronk is intensely interested in the metabolic requirements of nerve tissue, the problems of synaptic transmission in sympathetic ganglia, the action of single neurones, and the effects of chemical agents on the metabolism and function of nerve tissue.

New President for The Johns Hopkins University

Lowell J. Reed has been appointed president of The Johns Hopkins University, effective September 1, succeeding Detlev W. Bronk. Dr. Reed is internationally known for his contributions to biostatistics and public health administration. He has been influential in developing biostatistics to the point where its basic methods are being used by investigators in other scientific fields and in business organizations.

With the late Raymond Pearl, he developed the mathematical formula for the "logistic curve" relating to the growth of populations in all parts of the world. This enabled scientists to predict the growth of cities, states, and even countries. Using biostatistical methods, Dr. Reed made important contributions to the prediction of epidemics, their virulence, and their duration.

Dr. Reed was born in Berlin, New Hampshire, in 1886. He received his B.S. and M.S. degrees from the University of Maine and, in 1915, his doctorate from the University of Pennsylvania. He returned to the University of Maine to teach mathematics and physics before going to Washington, D. C., in 1917, to head the wartime Bureau of Tabulations and Statistics for the War Trade Board.

In 1918, Dr. Reed was appointed associate professor of biostatistics at The Johns Hopkins School of Hygiene and Public Health and 7 years later succeeded Dr. Pearl as professor and head of the Department of Biostatistics. He was made dean and director of the School in 1937, a position he held until 1947 when he became vice-president of The Johns Hopkins University in charge of medical activities. In 1949 Dr. Reed became the first person to serve as vice-president of both The Johns Hopkins University and The Johns Hopkins Hospital. In addition to playing a vital role in the development of these institutions in the past 35 years, Dr. Reed has continued his work in research and as scientific consultant. Between the two World Wars he served the government in many capacities.

Since 1940, he has been a consultant on manpower and medical statistics to the surgeons general of the Air Force, Navy, and Army, as well as to the U.S. Public Health Service, Selective Service, Department of State, National Research Council, and Veterans

Administration. He is also a member of the National Advisory Health Council.

Dr. Reed was chairman of the United States Delegation to the Inter-American Demographic Conference held in Mexico City in 1943. In 1947, he headed the United States Committee on Joint Causes of Death which won the Lasker Award in Public Health for its specific work on the International List on Morbidity and Mortality. Following World War II, he was a member of the President's Commission on the State of the Nation's Health.

A fellow and former president of the American Public Health Association, Dr. Reed is a fellow, director, and former president of the American Statistical Association; a former president of the Population Association of America; and a fellow of the American Medical Association.

Scientists in the News

Patrick James Fitzgerald, Assistant Pathologist at Memorial Hospital, New York, and Assistant in the Department of Physics in the Sloan-Kettering Institute, has been appointed Professor and Chairman of the Department of Pathology at the New York State University College of Medicine, Albany.

Edward J. Graul, soils, and **Ira R. Sisk,** surgery, have retired with emeritus status from the faculty of the University of Wisconsin.

Nathan S. Haseltine, medicine and science editor of *The Washington Post,* has been appointed Representative to the AAAS for the National Association of Science Writers. He succeeds **Herbert B. Nichols,** information officer of the U.S. Geological Survey and science writer for the *Christian Science Monitor,* who has served as the organization's AAAS Representative since 1947.

Clifton K. Himmelsbach has been appointed Assistant Chief, Division of Hospitals, Public Health Service, Department of Health, Education, and Welfare. Formerly Medical Officer in Charge of the U.S. Public Health Service Outpatient Clinic in Washington, D.C., Dr. Himmelsbach succeeds **Myron D. Miller,** recently assigned as Medical Officer in Charge of the U.S. Public Health Service Hospital, Seattle, Washington. As Assistant Chief of the Division of Hospitals, Dr. Himmelsbach's new responsibilities involve the administration of the 16 hospitals and 125 outpatient facilities that comprise the medical care program for legal beneficiaries of the USPHS.

Frederick Lee Hisaw, Professor of Zoology at Harvard University since 1935, has been named Fisher Professor of Natural History at Harvard. Dr. Hisaw is an embryologist, physiologist, and endocrinologist whose research has contributed to medical studies in obstetrical and gynecological problems. He was the discoverer, in 1944, of the female sex hormone, relaxin, and in 1951 received the Gold Medal of the American Society of Gynecologists for his research on basic biological aspects of the female reproductive tract.

Neil B. Hutcheon, Professor of Mechanical Engineering at the University of Saskatchewan since 1944, has accepted the appointment of Assistant Director of the Division of Building Research for the National Research Council of Canada, Ottawa.

José Oliver-Gonzalez, Associate Professor of Parasitology at the School of Tropical Medicine, University of Puerto Rico School of Medicine, has been appointed Chief, Parasitology Division, Tropical Disease Research Laboratory, U.S. Army, San Juan, Puerto Rico. He will continue his association with the School of Medicine as a lecturer in Medical Parasitology and will also be in charge of several research projects.

Two members of the General Electric Advanced Electronics Center at Cornell will teach in the university's School of Electrical Engineering next academic year. They are **H. R. Oldfield, Jr.,** operations manager at the Center, and **Ben Warriner,** an engineering supervisor. Mr. Oldfield, as a visiting professor of electrical engineering, will give courses in High Speed Analogue and Digital Electronic Computers; Mr. Warriner, a visiting associate professor, will teach Microwave Technics.

King Baudouin of Belgium recently presented the Cross of the Belgian Royal Order of the Lion and a $10,000 award to **Louise Pearce,** an American biologist, for her part in the discovery of tryparsamide, a drug used to fight sleeping sickness. Dr. Pearce conducted a study of the disease in the Belgian Congo.

The Belgian Government awarded a total of $18,000 to Dr. Pearce and her three American collaborators, who perfected tryparsamide at the Rockefeller Institute for Medical Research in New York 34 years ago. The drug is widely used in the Belgian Congo. **Walter A. Jacobs** of New Rochelle, N. Y., and **Michael Heidelberger** of Columbia University, received $2000 each and were presented the decoration of Officer of the Order of Leopold II. An additional $4000 was for the late **W. H. Brown** of Princeton.

Charles E. Price, who recently left his post as Medical Director of Hahnemann Hospital, Philadelphia, to assume the position of Medical Director of the General Hospital at Fresno County, Fresno, Calif., will be succeeded by **Harold A. Taggart,** Assistant Dean of Hahnemann Medical College. Dr. Taggart will serve in an acting capacity until a permanent appointment is made.

Eugene P. Reagan, a plant quarantine official for the U.S. Department of Agriculture since 1929, has been appointed Assistant Chief in charge of regulatory activities of the USDA's Bureau of Entomology and Plant Quarantine, Washington, D. C.

The Lamme Award of the American Society for Engineering Education, the highest honor in this

field, has been presented to **H. S. Rogers**, President of the Polytechnic Institute of Brooklyn.

The State University of New York College of Medicine, Syracuse, has appointed **A. Harry Rubenstein** as Professor and Chairman of the Department of Otolaryngology, and **Robert O. Gregg** as Professor and part-time Chairman of the Department of Surgery. Dr. Rubenstein has been a member of the college staff since 1925 and Dr. Gregg since 1941.

Grants and Fellowships

Eighteen new research contracts in mathematical studies have been negotiated with colleges and universities by the U.S. Air Force's **Air Research and Development Command** (**ARDC**), Baltimore. These contracts are among the more than 190 being monitored by ARDC's Office of Scientific Research with educational institutions throughout the United States for research in the mathematical, physical, and life sciences which support air technology.

The **Daniel and Florence Guggenheim Foundation** has awarded fellowships to ten men to enable them to carry on advanced study at the **Guggenheim Jet Propulsion Center, Princeton University.** The awards are granted annually to outstanding students who are selected for their technical ability, leadership qualities, and interest in the rocket and jet propulsion field. Each fellowship provides a stipend ranging from $1200 to $2000 for the year, plus tuition. The objective of this fellowship program is to train promising young men for leadership in the future development of rockets and jet propulsion, with emphasis on peacetime uses.

The **Florida State Museum** has completed negotiations with the U.S. Department of the Interior, through the **National Park Service,** which has made available a $1500 grant for the purpose of carrying out a biological survey of the lower Chattahoochee and Flint River Basins. The survey will involve the study of animals and plants found in territories which will be inundated by the construction of the Jim Woodruff Dam on the Appalachicola River. J. C. Dickinson, Jr., Curator of Biological Sciences at the Museum, will direct the field work which is already in progress.

Georgetown University has been awarded a grant of $38,873 by the **U.S. Department of Defense** to prepare equipment and train personnel for the next big solar eclipse which will take place on June 30, 1954. There are to be 15 observation sites within the path of the eclipse and these stations will be as far apart as Canada and Iran. Observers trained at Georgetown will measure the light of the eclipsed sun along the path of the moon's shadow with photo-electric cells. Other university groups participating in the project will use photography. The two methods will be checked against each other for accuracy.

The **National Science Foundation** will receive applications for a limited number of grants to assist in payment of travel expenses to six international scientific meetings in the mathematical, physical, and engineering sciences to be held during the latter half of 1954. The meetings of interest are:

International Union of Pure and Applied Physics, London, England, July 6–10, 1954. *Applications should be received before Dec. 1, 1953.*

World Power Conference, Rio de Janeiro, Brazil, July 25–Aug. 8, 1954. *Applications should be received before Dec. 1, 1953.*

International Union of Theoretical and Applied Mechanics, Brussels, Belgium, July 28–Aug. 2, 1954. *Applications should be received before Dec. 1, 1953.*

International Mathematical Congress and International Mathematical Union, Amsterdam and The Hague, Netherlands, Aug. 30–Sept. 9, 1954. *Applications should be received by Jan. 1, 1954.*

International Union of Geodesy and Geophysics, Rome, Italy, Sept. 16, 1954. *Applications should be received by Jan. 1, 1954.*

International Scientific Radio Union, Amsterdam, Netherlands, Sept., 1954. *Applications should be received by Jan. 1, 1954.*

Applications forms may be obtained upon request from the National Science Foundation, Washington 25, D.C.

The **National Science Teachers Association,** a department of the National Education Association, has announced the third annual program of **Recognition Awards for Science Teachers.** Awards of $400, $300, $200, and $100 will be given for the best reports of outstandingly good science teaching ideas and practices. Fields of instruction covered by the awards program include elementary science, junior high school science, and all areas of science at the senior high school level. Additional information about the program may be obtained by writing to the National Science Teachers Assoc., 1206 16th St., N.W. Washington 6, D.C.

New York University is launching a program of research to determine how sea-surface conditions, especially sea-surface temperatures, are influenced by the atmosphere. The **Office of Naval Research** has awarded the university's Engineering Research Division a year's contract for the investigation. Gerhard Neumann, Associate Professor of Oceanography, will direct it. The research will involve a study of the thermocline, an ocean layer through which the temperature changes abruptly. Variations of sea temperatures are of potential military significance because they influence sound propagation through the water and thus affect the operation of naval sounding devices.

It has been announced by the **Public Health Service, Department of Health, Education, and Welfare** that beginning July 1 applications for postdoctoral and special research fellowships in the field of mental health, as well as in other health fields, will be reviewed twice each year, rather than three times a year as at present. Such applications should be submitted *prior to Oct. 15 or Feb. 15*; awards will be announced

about three months later. Research grant applications will continue to be reviewed three times a year, with the following closing dates for the coming year: *Aug. 15, Nov. 1,* and *March 1.* Awards will be announced from four to five months after the closing dates. For further information and application forms, write to Dr. John C. Eberhart, Chief, Research Grants and Fellowships Branch, National Institute of Mental Health, Bethesda 14, Md.

The **Theobald Smith Award Committee** for 1953 has been appointed by E. U. Condon, President of the AAAS. The following men will serve: William B. Castle, M.D., Boston City Hospital; Harry S. N. Greene, M.D., Yale University School of Medicine; H. B. van Dyke, M.D., Columbia University College of Physicians and Surgeons; W. Barry Wood, Jr., M.D., Washington University School of Medicine. Cornelius P. Rhoads, M.D., of Memorial Center for Cancer and Allied Diseases and Vice President of AAAS Section N, is chairman, ex officio; and Allan D. Bass, M.D., of Vanderbilt University School of Medicine and Secretary of Section N, is secretary, ex officio.

A $1500 fellowship in physics at the University of Virginia has been renewed by the **United States Rubber Company** for the academic year beginning July 1, 1953. This was started in 1948. Other graduate fellowships provided by the U.S. Rubber Co. include those for science students at California Institute of Technology, Cornell University, Harvard University, University of Illinois, Massachusetts Institute of Technology, Northwestern University, University of California, University of California at Los Angeles, University of Chicago, University of Minnesota, and University of Wisconsin. There is also a fellowship in polymer physics at the University of Notre Dame. All these are now on a five-year basis.

In the Laboratories

The **Fleischmann Laboratories,** New York, N. Y., research and development unit of Standard Brands, Inc., will move to Stamford, Conn., on Sept. 15.

The first class was graduated recently from a new Aircraft Instruments School conducted by the **General Electric Company's** Meter and Instrument Department at its Lynn, Mass., plant. A comprehensive course on G-E's new jet engine flowmeter was offered during the session. The School was attended by Royal Canadian Air Force squadron leaders, Douglas Aircraft engineers, G-E service engineering representatives, and company sales engineers. Additional sessions on G-E aircraft instruments will be held later this year for other groups.

The formation of the **Matholin Corporation** to manufacture, sell, and conduct research on hydrazine, a new commercial chemical, has been announced jointly by John M. Olin, President of Olin Industries, Inc., and Thomas S. Nichols, President of the Mathieson Chemical Corporation. The new company will be owned equally by the two men, and its first plant will be one recently completed by the Mathieson Chemical Corporation at Lake Charles, La. Heretofore hydrazine has been a laboratory curiosity, but some 2000 derivatives have now been reported. The material, or its derivatives, is being used in medicinal, agricultural, plastic, and many other products.

The **National Vitamin Foundation, Inc.,** has moved to more adequate quarters at 15 East 58th Street, New York, N. Y.

The Engineering Division of the **Stanford Research Institute** has revised and expanded the organization of its Aircraft Radiation Systems Laboratory. Expansion of industrial services in aircraft and communications programs has necessitated the regrouping of related technical sections into a division to be known as the Radio Systems Laboratory. Also, the broadened scope of research and development in the areas of radio communications at the Institute has made it desirable to change the name of the Single Sideband Communications Group to that of Communications Group. Formerly a separate research section, the Communications Group will henceforth be a part of the Radio Systems Laboratory. Heading the new structure will be J. V. N. Granger, Assistant Chairman of the Engineering Department. The Assistant Head is John T. Bolljahn.

The Isotopes Division, **U.S. Atomic Energy Commission,** Oak Ridge, Tenn., has reorganized its technical staff. The Isotopes Division is the AEC unit responsible for the national and international distribution of stable and radioactive isotopes. Under the new arrangement, the Division will consist of three major branches. The Allocations Branch will review and act upon all applications for isotopic materials. The Radiological Safety Branch will assist radioisotope users in matters of health protection, and the Technical Developments Branch will be responsible for preparing and disseminating information on isotope utilization and for outlining and encouraging training in isotope techniques. Key personnel of the Division are: Paul C. Aebersold, Director; Charles E. Crompton, Assistant Director; Stephen P. Cobb, Jr., Technical Assistant to the Director; James R. Mason, Chief, Allocations Branch; G. W. Morgan, Chief, Radiological Safety Branch; and Edwin A. Wiggin, Chief, Technical Developments Branch.

U.S. Steel has started construction of a modern research center devoted to the development of new processes for making better steels, to be located in Monroeville, Pa. Plans call for three buildings with a total floor area of 132,000 square feet which will house experimental equipment for studying every phase of steel processing from the raw material stage to the finished product. Equipment will range from electron microscopes to pilot lines for tin-plating and for coating of other metals.

Miscellaneous

Cortisone (compound E) and **hydrocortisone** (compound F) have been atomically labelled with carbon 14 for the first time, it has been announced jointly by the National Institutes of Health, Sloan-Kettering Institute and the Worcester Foundation for Experimental Biology. They now are available free of charge to investigators who wish to study their mode of action. It was emphasized that this significant accomplishment which makes available a new and important investigative tool is not a new form of cortisone treatment. The synthesis of these hormones is the result of a large cooperative enterprise on the part of the United States Government, private research organizations and commercial pharmaceutical companies.

Requests for these materials should be addressed to Endocrinology Study Section, National Institutes of Health, Bethesda 14, Maryland. Funds made available by the National Institute of Arthritis and Metabolic Disease, U.S. Public Health Service makes possible their free distribution for research purposes. Transfer and use of these materials are subject to current Atomic Energy Commission regulations.

The **National Society for the Prevention of Blindness**, New York, has announced the establishment of a new **Editorial Research Advisory Service.** Its purpose is to assist magazine editors in the collection and dissemination of accurate information about the human eye in the interests of saving sight and preventing blindness. The Service is supported by voluntary contributions and is available at no charge.

Fifty-nine medical scientists from 20 countries have joined in the authorship of a book in tribute to Robert Wartenberg, neurologist in the University of California School of Medicine, San Francisco. The book, ***Neurological Problems in the World in 1953,*** has just been published by the *Journal of Nervous and Mental Disease*. Financing of the volume came from Dr. Wartenberg's many professional and nonprofessional friends. The volume was printed in honor of Dr. Wartenberg's 65th birthday, which occurred on June 19, 1952. It was edited by Dr. Webb Haymaker, now of the Armed Forces Institute of Pathology and formerly of the U.C. School of Medicine.

Two thousand tons of steel are going into the building of a new **radio telescope** at Manchester University, England. In shape, it will be something like a monster searchlight, with a steel bowl that alone weighs 130 tons and will stand on steel towers 180 feet high. The whole instrument will ride on a circular railway so that it can be aimed at any part of the sky. Radio telescopes are concerned with sound, not light. They collect the radio waves from distant stars and then record them with a pen on a moving paper chart.

A **survey of national research councils** throughout the world made by the United Nations Educational, Scientific, and Cultural Organization shows that 28 countries have established some sort of central agency for the promotion of research in different fields of pure and applied science. Some countries, like the United States, have more than one such organization. The National Research Council in the United States shares with Britain's Department of Scientific and Industrial Research the distinction of having begun operation in 1916, which is the earliest for organizations of this sort. The UNESCO report calls these research councils "the most modern development of the relations between scientific workers and the government."

Recent **visitors from abroad** at the National Bureau of Standards:

Gerhard O. W. Wiedemann, Chief of the Dept. for maritime navigational aids and signals in the Federal Ministry for Transport, Federal Republic of Germany.

Paul F. J. Jainski, Engineer in the Federal Ministry for Transport in the Maritime signals Testing Field, Federal Republic of Germany.

Otto H. Schoppe, Director of the Dept. for Inland Navigation on the Rhine River in the Federal Ministry of Transport, Federal Republic of Germany.

Carl Fischer, Head, Dept. of Restorative Dentistry, University of Göttingen, Germany.

Rupert Vallentine, N.S.W. University of Technology, Sydney, Australia.

John H. Chapman, Physicist, Department of National Defence, Ottawa, Ontario, Canada.

Hans C. Freeman, Lecturer in Chemistry, University of Sydney, Australia.

Sasi Punyamanob, Department of Science, Bangkok, Thailand.

Heinz Detering, Head of Corrosion Protection Dept. Th. Goldschmidt A.-G., Essen, Germany.

Willi Geilenkirchen, Chief of Varnish and Lacquer Materials Laboratory, Farbenfabriken Bayer, Krefeld-Uerdingen, Germany.

Leendert van Assendelft, Plant Design Engineer, Algemene Kunstzijde Unie N.V., Velperweg 76, Arnhem, Netherlands.

Erling Mikkelsen, Technical Director, A/S Den Kemiske Fabrik Norden, Oslo, Norway.

H. L. Hardwick, Dean, Royal College of Dental Surgeons, Royal Dental Hospital, London, England.

Giorgi Nielsen, University of Bologna, Bologna, Italy.

Morisaburo Katakami, Research Engineer, Yokagawa Electric Works, Ltd., Tokyo, Japan.

H. Harvey Bryan, Inspector of Factories, United Kingdom.

Alexius T. Ree, Professor of Chemistry, Korea.

P. A. Forsyth, Physicist, Department of National Defense, Ottawa, Ontario, Canada.

A. F. Wilkins, Research Scientist, Department of Scientific and Industrial Research, Slough, Bucks., England.

Technical Papers

Floral-Faunal Associations in American Coal Balls[1]

S. H. Mamay and E. L. Yochelson

U. S. Geological Survey, Washington, D. C.

Coal balls are accumulations of fossil plant material that has been impregnated with calcium or magnesium carbonate, iron sulfides, and minor amounts of other mineral constituents. These nodules differ considerably in size and shape, ranging from the size of an acorn to masses hundreds of pounds in weight and from spherical to elliptical, or lens shaped. Besides these, however, huge irregular masses of coal ball material several tons in weight have been found. Coal ball material occurs only within bituminous coal seams that are capped by marine limestone. Geographically, it is widely distributed, and occurrences have been reported in the United States, England, western Europe, Spain, and the Donetz Basin of Russia. So far as is known, coal balls are confined to strata of Late Carboniferous or Pennsylvanian age (*1*).

Coal balls have been known for a century in England and for about three decades in the United States. Their organic content is commonly preserved in the most minute detail and is conveniently investigated by means of the Parlodion peel technique (*2*). Such investigations have contributed much to our knowledge of Pennsylvanian plants, as, for example, the discovery of the Paleozoic pteridosperms, a bizarre group of fernlike plants that bore seeds.

In any discussion of coal balls, questions concerning their origin and nature arise, and it is hoped that continuing investigations of the material discussed in this preliminary report will eventually shed some light on these questions. The purpose of the present paper is to describe the features with which any hypothesis of origin must be consistent rather than to venture possibly premature conclusions.

During the field season of 1952, Mamay collected coal balls from a stream-bed exposure near Berryville in southern Illinois and from strip pits of the Pittsburgh and Midway Coal Company near West Mineral in southeastern Kansas. The bulk of these collections, totaling somewhat more than a ton in weight, contains the usual assemblage of plant stems, roots, leaves, and fructifications, but a few of these coal balls are remarkable because they carry an association of marine invertebrate and terrestrial plant fossils such as has not, to our knowledge, previously been recorded. It is this new material on which the following discussion is primarily based.

The Kansas collection consists of approximately 150 coal balls. Five of these were found to contain a diverse assemblage of marine invertebrate remains, homogeneously scattered among the plant fragments. Since many of the invertebrates are preserved as molds or replacements by silica or pyrite, both of which are insoluble in dilute hydrochloric acid, chunks of the coal balls were dissolved in this reagent. The reaction was allowed to continue until all the carbonates were dissolved; the remaining sludge was dried, sieved through coarse screens, and examined for organic remains. The following invertebrates, which comprise a typical Pennsylvanian fauna, have tentatively been identified by the authors with the assistance of various colleagues:

Foraminifera: *Tolypammina* sp.
?Porifera: New genus.
Pelecypoda: *Schizodus* sp.; *Parallelodon* sp.; *Pleurophorus* sp.; *Astartella* sp.; *?Pterina* sp.; fragments of several other genera.
Gastropoda: *Glabrocingulum* sp.; *?Anomphalous* sp.; *Donaldina* sp.
Brachiopoda: *Chonetes* sp.; *Marginifera* sp.; *Derbyia* sp.
Ostracoda: *Hollinella* sp.

These coal balls also contain numerous roughly spherical pellets, consistently about 1 cm in diameter. They are dark brown and stand out in marked contrast with the generally lighter colored matrix. These pellets are composed of small bits of finely macerated plant tissues and are interpreted as the fecal pellets of an herbivorous animal.

Large plant fragments have not been recovered by the acid treatment. However, smaller bits are abundant in the organic residues and have been recovered in a fully distended, uncompressed condition.

Megaspores are the most abundant of the plant structures found in the residues. Most of these are large, spherical trilete forms; one type averages about 3 mm in diameter and bears a wide equatorial frill with delicate spongy texture. Preservation of the larger spores is so good that the thin endosporal membranes may be dissected out. The proximal portions of most of these membranes contain a number of small, evenly distributed, dark round spots. Their size, distribution, and restriction to the proximal parts of the spores suggest that these spots may represent the remains of archegonia.

The preservation of the fossils presents an interesting problem in replacement. As a general rule, the brachiopod shells remain calcareous and must be mechanically removed from the matrix for study. Ostracods and pelecypods, as well as a few brachiopods, are pyritized; gastropods are calcareous, pyritized, or silicified. Furthermore, many of the spores contain internal molds, either pyritic, calcareous, or siliceous. The surfaces of many of the molds show the triradiate

[1] Publication authorized by the Director, U. S. Geological Survey.

marks that appear on the proximal surfaces of the spores.

Several coal balls also containing invertebrates were found in the collection from the Berryville locality in Illinois. These differ from the Kansas material in several aspects and serve to enhance the general interest of this problem.

Although invertebrates are homogeneously scattered through the matrix of the Kansas coal balls, the animal content of the Berryville material is restricted to a clearly defined mass of marine limestone located at or near the center of the coal ball. The limestone is in the form of elongate, more or less rounded, rod-shaped masses and is lithically and faunally similar to the marine limestone immediately overlying that part of the coal seam where the coal balls occur. The contact between the included limestone mass and the remainder of the coal ball is generally sharp, but an occasional plant axis may extend about 1 cm into the limestone. Scattered bits of plant debris are present within the limestone masses, but the organic content is predominantly of invertebrate origin.

With the exception of some pyritized bryozoans, the invertebrate remains in the Berryville material are calcareous and hence not adapted to the hydrochloric acid treatment. They have been studied by mechanical preparation. Unlike the Kansas specimens, they are not readily determinable to the generic level.

The faunal assemblage in the Berryville coal balls is somewhat different from that of the Kansas balls. The following invertebrate remains have been tentatively identified:

Foraminifera: calcitarnellid forms.
Coelenterata: lophophyllid coral.
Echinodermata: crinoid stems, seemingly all of one type.
Bryozoa: rhomboporoid forms.
Gastropoda: Three shell types observed in various sectional planes.
Pelecypoda (or Brachiopoda): Small biconvex sections and scattered shell fragments.

Pellets similar in size, shape, and content to those found in the Kansas material are present in the Berryville coal balls. Some of the Berryville specimens, however, are unusual in that they contain an abundance of small spores, all apparently of the same kind. It is difficult to explain such concentrations of spores outside the sporangium itself, unless one considers them as having been concentrated in the intestines of herbivorous animals and preserved as coprolites. Occasionally the diets of these herbivores included fertile foliage; this would explain the presence of many spores in some of the pellets and their complete absence in others.

Although the primary purpose of this communication is to report this unique plant-animal association in American coal balls, we wish briefly to mention the outstanding problems posed by this material.

The occurrence of invertebrate-containing coal balls among normal plant-bearing coal balls and the inclusion of marine limestone masses within otherwise normal individual coal balls is difficult to explain. That some transportation of material was involved is suggested by the swirled or rolled structure of the invertebrate-containing coal balls as contrasted with the bedded structure of normal coal balls, as well as by the fact that occasional spores, cuticles, and other terrestrial plant structures bear adherent tests of marine Foraminifera. It is hoped that distances and modes of transportation involved may be determined by further field observations, formulated to test alternative hypotheses suggested by laboratory studies.

The chemical processes involved in the preservation of the fossils is perplexing. One might assume that differences in mineral replacement of these fossils by and large reflect differences in the original composition and structure of the organisms. This alone, however, does not explain the occurrence, in the same coal ball, of both silicified and pyritized specimens of gastropods that obviously belong to the same species, or the fact that internal molds of the same species of spores may be calcareous, pyritic, or siliceous.

The origin of the carbonates that form the matrix of the coal balls needs explanation. This calls for studies of the associated sediments and considerations of chemical relationships between marine and coal swamp waters.

An investigation of this problem is now being carried out, with a view to publication in a forthcoming paper. In addition to discussions of the questions mentioned, it is intended that this paper will include a systematic analysis of the fauna and flora associated in these coal balls.

References

1. ANDREWS, H. N. *Botan. Rev.*, **17**, 431 (1951).
2. DARRAH, W. C. Harvard University Botanical Museum Leaflets, **4**, 69 (1936).

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Bilateral Interaction in the Lateral Geniculate Body[1]

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In the higher vertebrates the lateral geniculate body is the only synaptic center on the direct path between retina and cerebral cortex. With the partial decussation that occurs in the optic chiasma, it might be expected that the preliminary mechanisms concerned in binocular fusion would be located in the lateral geniculate body. It is widely believed (*1, 2*), however, that the pathways from each eye retain their separateness both anatomically and physiologically through the synapses in the lateral geniculate up to the visual

[1] Aided by grants from the National Health and Medical Research Council of Australia and the A. E. Kahn Donation.

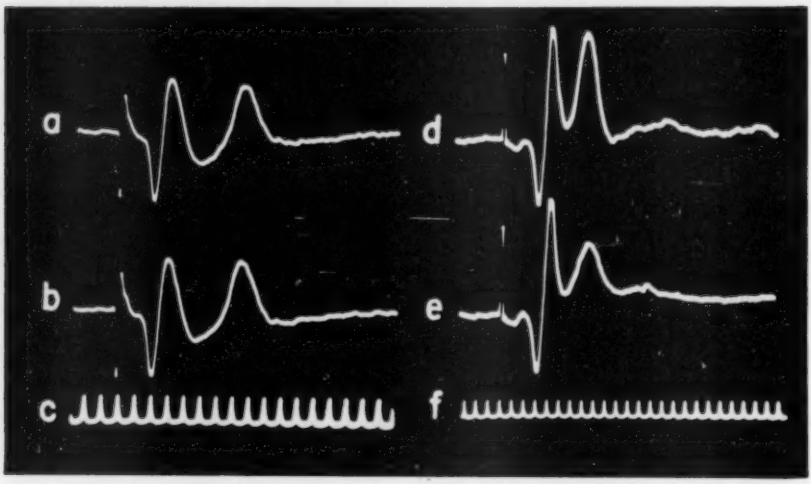

FIG. 1. *a* and *b*: responses recorded in the optic tract to maximal contralateral optic nerve stimulation; *a*, before, and *b*, 6 msec after, ß maximal stimuli (at 380/sec) applied to the homolateral optic nerve. *c* and *d*: responses recorded in lateral geniculate to stimulation of large diameter fibers in the contralateral optic nerve; *a* and *b*, parameters of stimulation as for optic tract recording. *e* and *f*: time intervals 0.2 msec.

cortex. Anatomically, fibers from each eye terminate in separate layers in the geniculate and there is no evidence that the layers are interconnected (*2*). Physiologically, in 1941 Talbot and Marshall (*3*) briefly reported the unexpected finding of binocular interaction at the geniculate by applying conditioning shocks to one optic nerve and test shocks to the other. Later, however, in a more detailed report Marshall (*4*) "never observed any specific interaction at the geniculate level." Nevertheless Marshall found a reduction in all components of the test response for conditioning shock—test shock intervals up to about 10 msec. Both the presynaptic and postsynaptic responses were equally diminished by about 5% regardless of which nerve was stimulated first. He regarded this as due to interfiber interaction in the optic chiasma and tract.

Work in progress in this laboratory has now provided clear evidence that interaction does occur in the lateral geniculate leading to both facilitation and depression of the geniculate response. The interaction process has been studied through the recovery cycle of the geniculate cells in the cat under intraperitoneal Dial (Ciba) (0.6 ml/kg) anesthesia by applying conditioning shocks to one optic nerve and test shocks to the other. A microelectrode inserted into the brain by means of a stereotaxically directed micromanipulator has recorded the response of the optic tract and of the lateral geniculate against an indifferent electrode placed in the temporal muscle. Despite Marshall's finding to the contrary (*4*), no evidence has been obtained which would indicate that impulses set up in the tract fibers from the one eye are affected by impulses in the tract fibers from the other eye. The response to a maximal stimulus applied to the contralateral optic nerve as recorded in the optic tract is shown in Fig. 1a. The two negative going spikes correspond to the two groups of fibers in the optic nerve (*5*). In Fig. 1b the same test response has been conditioned by a train of six maximal shocks at 380/sec applied to the homolateral optic nerve, commencing 24 msec before the test shock. The conditioned and unconditioned responses are identical and indeed remain so whatever the conditioning shock—test shock interval.

The response as recorded within the lateral geniculate following stimulation of the group of fibers of larger diameter in the contralateral optic nerve is shown in Fig. 1d. The first positive-negative spike is the large fiber tract spike and this is followed by a negative spike representing the discharge of impulses up the optic radiation. In Fig. 1e the same test shock as for Fig. 1d was preceded by a train of maximal conditioning shocks applied to the homolateral nerve with parameters identical with those used for the response in Fig. 1b. It will be seen that the tract spike remains unaffected by the radiation spike suffers a reduction of 41% of its unconditioned amplitude. Almost as marked a degree of interaction is revealed if the test response to the contralateral nerve is conditioned by a single shock to the homolateral nerve. The response of Fig. 2a is similar to that of Fig. 1d. In Fig. 2b the same contralateral test response has been preceded by a homolateral response of approximately similar size at a conditioning shock—test shock interval of 20 msec. Again the tract spike is unaffected but the radiation spike is reduced by 38%. The radiation spike is even more affected if a maximal homolateral conditioning shock is used. By varying the conditioning shock—test shock interval, an

early phase of interaction facilitation is shown to be succeeded by a prolonged phase of interaction depression. A similar result is obtained if the test shock is applied to the homolateral nerve, and the conditioning shock to the contralateral nerve.

These results indicate that there is interaction between the separate cell layers (A and B) of the contralateral eye and layer (A_1) of the homolateral eye in the dorsal nucleus of the lateral geniculate body of the cat, and not between the presynaptic fibers to these layers.

Possible explanations for these findings are: (1) The presynaptic fiber endings synapse on the cells in the layer or layers of the other side. The anatomical evidence is clearly to the contrary. (2) Flows of current associated with the activity of one cell layer pass through and affect cells in the adjacent layer or layers of the other side.

That flows of current associated with the activity of cells and fibers may influence the excitability of adjacent normal resting cells and fibers is now a well-attested experimental finding (*6*), but the situations in which this phenomenon has been studied in the central nervous system have usually involved techniques such as antidromic activation, which make the assessment of the findings in terms of normal function somewhat uncertain. If the explanation suggested above is accepted, interaction in the geniculate is an example of the probable importance in normal function of flows of current in determining excitability at a distance. It may well be that the layering in the geniculate, a feature which is carefully preserved through the vicissitudes of phylogenetic development, is of importance in allowing these flows of current to assume an influence that they possibly would not have in a more random arrangement of nervous elements. This phenomenon may also be of importance within a particular layer of cells. The early phase of facilitation which is seen in the recovery cycle of geniculate cells following unilateral conditioning and testing has been explained (*4*) on the basis of reciprocal overlap of optic tract fiber endings. It is possible, however, that some of this facilitation may be due to flows of current within the layer where the stimulated fibers actually terminate. The relationship of the phenomenon of interaction to the excitability cycle and to the after-potentials of the geniculate cells has also been studied and these and other findings will be published in detail later.

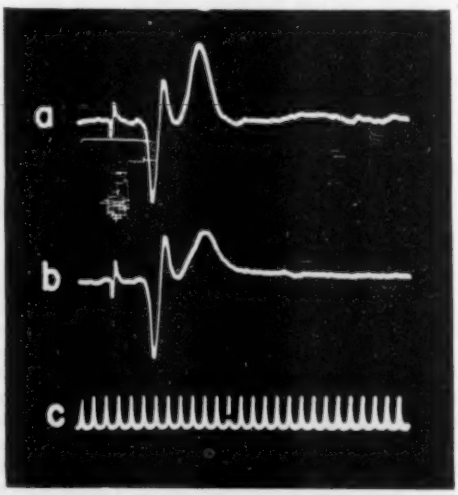

FIG. 2. *a* and *b*: responses recorded in laterial geniculate to stimulation of large diameter fibers in contralateral optic nerve; *a*, before, and *b*, after, a stimulus to the homolateral optical nerve similar in strength to that applied to the contralateral nerve. *c*: time intervals 0.2 msec.

References

1. BISHOP, G. H., and O'LEARY, J. L. *J. Neurophysiol.*, **3**, 308 (1940).
2. O'LEARY, J. L. *J. Comp. Neurol.*, **73**, 405 (1940).
3. MARSHALL, W. H., and TALBOT, S. A. *Am. J. Physiol.*, **129**, 417 (1940).
4. MARSHALL, W. H. *J. Neurophysiol.*, **12**, 277 (1949).
5. BISHOP, P. O., JEREMY, D., and LANCE, J. W. *J. Physiol.* (in press).
6. LLOYD, D. P. C. *J. Gen. Physiol.*, **35**, 289 (1951).

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Stimulation of Rubidium Absorption by Auxins

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Among the more immediate and direct effects of auxins on plant cells are their stimulation of water uptake (cell enlargement) and of respiration (*1*). The effects of auxins on ion uptake are less clear, owing to the fact that both stimulation and depression have been found. The present report[2] definitely confirms the important conclusion of Commoner and Mazia (*2, 3*) that auxin may stimulate ion uptake in excised tissues. The results reported here outline more clearly the conditions associated with auxin-induced ion uptake and indicate some correlation between respiration and absorption of both ions and water. The conclusion that the mechanism of auxin action lies in stimulating water uptake through increased osmotic salt concentration in the cell sap (*2, 3*) has been previously criticized (*4–6*) on the basis that auxin-induced water uptake does not require the presence of salts in the external solution, and that auxin results in lowering the osmotic concentration in the cell, rather than increasing it. The present results also do not support the conclusion that the

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[2] More detailed manuscripts of these studies are in preparation for publication elsewhere.

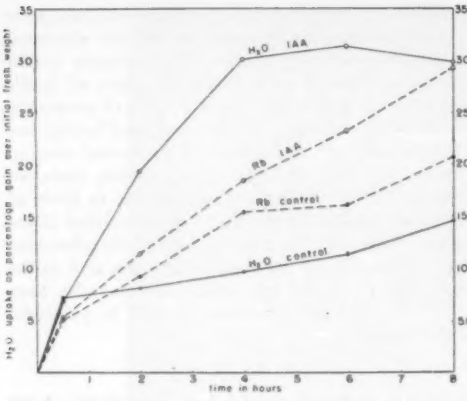

FIG. 1. Percentage increase in fresh weight and increase of Rb absorption by pea epicotyl segments in presence and absence of 1 ppm indoleacetic acid. RbCl concentration 5 meq/ml.

water uptake is induced by osmotic phenomena, rather they indicate a stimulation of both water and mineral ion uptake mediated through respiration.

The effect of auxins in stimulating ion uptake in excised tissue appears to be distinctly at variance with responses of intact plants (*7*). However, the present results seem consistent with the reports that auxin may induce greater uptake by seedlings of water and of salts (*8*), and that auxin-induced tumors have higher amounts of salts than other portions of the plant (*9*).

ously aerated either in 100 ml of solution in an Erlenmeyer flask or in a manometer vessel of a Warburg respirometer. Flasks were maintained at 25° C by use of a water bath in an undarkened laboratory. A minimum of 10 epicotyl segments or disks was used in each experimental flask. These generally were run in duplicate. The auxins used were β-indoleacetic acid (IAA) and α-naphthalene acetic acid (NAA).

The pea epicotyl segments respond to IAA within 2 hr as shown both by increased fresh weight and greater Rb absorption (Fig. 1). This stimulation by IAA is apparent throughout the first 8 hr. Experiments extended over longer intervals (in a lighted laboratory) show that most of the response to IAA is attained during the first 8 hr for both water uptake and salt absorption. In fact, at 48 and 72 hr there appears to be a tendency for the controls to catch up in Rb absorption with the IAA-treated segments despite that fact that the differential in fresh weight persists at the levels attained within the first 24 hr.

In contrast with pea epicotyl segments, rutabaga (Table 1) and potato showed a much slower response to auxin in absorption of both water and Rb. Significant differences due to auxin did not appear before the 3rd or 4th day, but then both water and Rb uptake were greater than in the controls. It should be noted that auxin-induced water uptake in general is less when tissue is submerged than when floating (*10*); however, maximum ion absorption requires vigorous circulation of the external solution so that the experimental conditions reported here were not ideal from the standpoint of both water absorption and ion absorption. Also as shown with rutabaga tissue in Table 1, increased Rb absorption was not necessarily reflected by the Rb concentration per unit final fresh weight. Generally, however, the increase in absolute amount, or in equivalents per unit of original fresh weight or dry weight was substantial. Thus it may be concluded that stimulation of growth as revealed by increase in fresh weight may be accompanied by an increased uptake of cations.

The question naturally arises as to whether Rb and

TABLE 1

EFFECT OF IAA ON RUBIDIUM AND WATER UPTAKE BY DISKS OF RUTABAGA TISSUE

Treatment	Water uptake	Rubidium uptake by disks							
	gain in fresh wt (%)	meq/sample		Initial wt		Final wt		Dry wt	
		meq/g	(%)	meq/g	(%)	meq/g	(%)	meq/g	(%)
2 days									
0.0 ppm IAA	15	59	100	23	100	20	100	269	100
1.0 ppm IAA	26	58	98	23	100	18	90	267	99
10.0 ppm IAA	25	58	98	23	100	18	90	262	97
4 days									
0.0 ppm IAA	21	86	100	33	100	28	100	388	100
1.0 ppm IAA	49	108	126	43	130	29	103	535	138
10.0 ppm IAA	49	107	125	41	124	28	100	542	139

In the present work radioactive rubidium, Rb^{86}, was used as a tracer in RbCl solution to follow cation uptake. The tissues used were 5-mm segments of the 3rd internode of epicotyls from 7-day Alaska pea seedlings grown in the dark, disks of rutabaga tissue, and disks of potato tuber tissue (Katahdin var.). Rubidium absorption was measured by counting wet-ashed samples using a 2.5 mg/cm² mica window Geiger tube, a standard scaling circuit, and an automatic register. The tissues in each case were submerged and vigor-

water move separately or together during the interval in which the absorption of both is stimulated by auxin. The evidence here, as in general, indicates a marked independence of rates in the two processes. Furthermore, a test with pea epicotyl segments in various osmotic concentrations of mannitol shows clearly that large changes in water uptake, or loss, may occur with no significant effect on Rb absorption (Fig. 2). It seems clear, therefore, that net water movement is not directly related to Rb absorption.

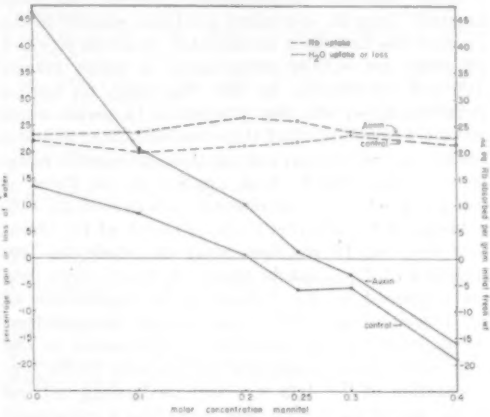

FIG. 2. Effect of 0.1 ppm IAA on Rb uptake by pea epicotyl segments during uptake or loss of water in various osmotic concentrations of mannitol. RbCl concentration 5 meq/ml.

The fact that rates or net movements of water and ions may differ markedly is not conclusive evidence that there is no relation between the two processes. In fact, it is now well known that, in addition to the passive phases of uptake, the accumulation and retention—above external concentrations—of both water and salt may be regulated by oxidative respiratory activity. Whether the metabolic mechanism responsible for active water absorption is different from that for salt accumulation is not known. This would require knowledge of the flux of each—water and salt—at the cell boundary and of the amounts of respiratory energy required for retaining each at given states. Preliminary tests measuring respiration of pea epicotyl segments do show that the stimulation by IAA does, as expected, include oxidative respiration as well as water and salt uptake (Fig. 3). The increase in amounts of Rb and O_2 absorbed over that of the controls is within the same order of magnitude percentage-wise. No doubt the most important relation here is the increase in oxidative respiration which directly or indirectly supplies the driving force for both water and Rb accumulation.

The proportions of energy channeled into water uptake as opposed to that for Rb absorption are, of course, not readily measurable. However, it may be concluded from the results of the osmotic concentration tests that major reductions in the potential diffusion of water (with increased mannitol concentration) had no appreciable influence on Rb uptake (Fig. 2). It might be inferred that the imposition of a concentration gradient favoring withdrawal of water from the cell might result in channeling more energy into the process of water absorption or retention (perhaps at the sacrifice of energy for cation uptake). While the results of the pea segment test (Fig. 2) show some increase in Rb uptake in the range near isotonicity, it seems clear that a great stress (resulting in partial plasmolysis) on water retention fails to halt Rb accumulation. In this range of mannitol concentration, 0.3 *M*–0.4 *M*, IAA failed to induce either a significantly higher absorption of Rb or a significantly greater water retention. It would appear, therefore, that whereas active water uptake and Rb absorption share some effect of auxin in common, this effect does not consist primarily in the direct competition of the two processes for respiratory energy. In similar experiments with potato disks there is evidence suggesting some competitive effect between water and salt on the basis of relatively greater Rb absorption in the isotonic range.

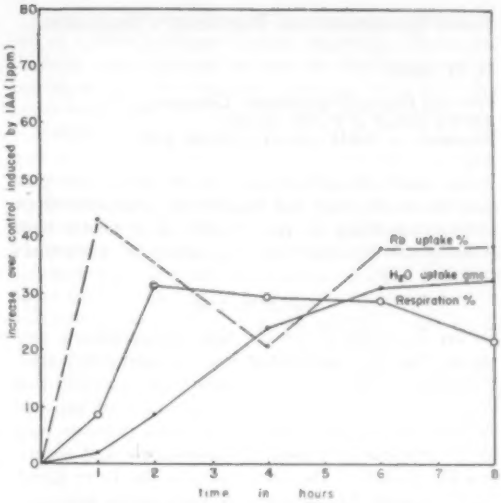

FIG. 3. Effect of 1 ppm IAA on the increase over the control of oxidative respiration, water uptake and Rb uptake. Pea epicotyl segments in 5 meq RbCl/ml.

References

1. BONNER, J., and BANDURSKI, R. S. *Ann. Rev. Plant Physiol.*, **3**, 59 (1952).
2. COMMONER, B., and MAZIA, D. *Plant Physiol.*, **17**, 682 (1942).
3. ———. *Am. J. Botany*, **31**, 8s (1944).
4. VAN OVERBEEK, J. *Ibid.*, 265.
5. LEVITT, J. *Plant Physiol.*, **23**, 505 (1948).
6. HACKETT, D. P. *Ibid.*, **27**, 279 (1952).
7. SCHUFFELEN, A. C. *Plant and Soil*, **1**, 121 (1948).
8. HAMNER, C. L. *Botan. Gaz.*, **103**, 374 (1942).
9. BRUNSTETTER, B. C., *et al. Ibid.*, **109**, 268 (1948).
10. THIMANN, K. V., and BONNER, W. D., JR. *Am. J. Botany*, **35**, 271 (1948).

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Some Extensions of Hammett's Equation

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The effect of substituents in the *meta* and *para* position on the rate and equilibrium constants of reactions occurring in side chains of aromatic compounds can be expressed by means of Hammett's equation (*1*):

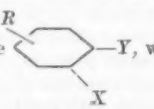
$$\log (k/k^0) = \sigma\rho \qquad (1)$$

In Eq. 1, k and k^0 are the rate or equilibrium constants for the substituted and unsubstituted compounds respectively, σ is the substituent constant that depends only on the nature and position of the substituent, and ρ, the reaction constant, depends only on the reaction, the conditions under which it occurs, and the nature of the side chain. In the form given, Eq. 1 applies to reactions of compounds having a single substituent in a benzene ring attached to the reacting side chain. Extensions to certain more complicated types of compounds will now be proposed.

In a few reactions (*2*) the effects of several substituents in the 3, 4, and 5 positions relative to the reacting side chain have been observed to be additive. Since these reaction series obey Eq. 1, the effect of multiple substituents can obviously be expressed through the sum of their substituent constants:

$$\log (k/k^0) = \rho\Sigma\sigma \qquad (2)$$

Although the evaluation of the literature is not complete at this time, it appears that Eq. 2 generally is a good approximation to the effect of multiple substituents. However, substituents which interact strongly with each other probably must be excepted from this generalization.

Measurements have been made on a few reaction series of compounds of the type 

, where R is a substituent in the 4 or 5 position relative to the reacting side chain Y, and where X, a substituent in the 2 position, is the same throughout the series. Where comparison is possible for several groups X (*3–4*), (which may include X = H), the reaction constants (ρ) are almost always equal within experimental error. Accordingly, such sets of reaction series for several X can be expressed by the single equation

$$\log (k/k^0) = \sigma\rho + X \qquad (3)$$

Here X is the effect the substituent X in the *ortho* position exerts on the reactivity of unsubstituted compound C_6H_5Y; i.e., $X = \log (k_X/k^0)$. The applicability of this equation is naturally subject to the limitation that the substituent X does not affect the mechanism of the reaction.

Equation 3 applies also to the extensive series of nuclear chlorinations of benzyl phenyl ethers (*5*). In this case X represents the cumulative effect of the several substituents in the phenyl group, and σ refers to the substituent in the benzyl group. It might have been anticipated that the effect X could have been correlated with substituent constants, but no such correlation was observed, probably because the substituents in the phenyl group affect the number and steric accessibility of the reaction sites.

Many reactions of compounds having 2 or more aromatic rings in equivalent positions relative to the reaction site have been investigated. In series in which all rings are equally substituted, or which involve different substituents on one ring only, no special problems arise, and Eq. 1 applies. In series which involve a combination of these two situations and also further unsymmetrical substitution, Hammett's equation has occasionally been applied in the form of Eq. 2 (*6*), where the summation extends over the substituents in the different rings. A search of the literature revealed 10 reaction series on which this application of Eq. 2 can be tested. Although more data are expressed by Eq. 2 than by the application of Eq. 1 to either the series of symmetrical compounds or the series involving variation of substituents in one ring only, it was found that the precision in the representation of the data was only moderately reduced by the use of Eq. 2. This fact shows that a substituent in one ring does not greatly affect the susceptibility of the reaction to the influence of a substituent in another ring.

There is no reason to believe that this conclusion should not apply equally to compounds in which several aromatic rings are in nonequivalent positions relative to the reaction site. Hence, for reactions of such compounds the following equation is proposed:

$$\log (k/k^0) = \sigma_1\rho_1 + \sigma_2\rho_2 + \cdots \qquad (4)$$

where ρ_1, ρ_2 $\cdots$ measure the susceptibility of the reaction to the effect of substituents in rings 1, 2 $\cdots$, and σ_1, σ_2 $\cdots$ refer to the substituents in the respective rings. Only two reaction series could be found in the literature on which Eq. 4 could be tested (*7*), and it was found to apply satisfactorily to both.

It might have been anticipated that Eq. 4 would also apply to reactions of the type A + B $\rightarrow$ products, if both A and B contain a substituted aromatic ring. However, examination of the literature revealed several reaction series of this type (*4, 8*), which did not obey Eq. 4 even approximately.

The four extensions of Hammett's equation proposed in this note obviously cannot express the experimental data with greater precision than Eq. 1, but rather can be expected to have somewhat lower precision. Since Hammett's equation itself is not highly precise these extensions can give only crude estimates of reactivities. However, it is believed that Eq. 2–4 should be useful since they permit representation of a much larger body of data by a single expression.

The detailed data on which these considerations are based will be published in the near future in connection with a review of Hammett's equation.

References

1. HAMMETT, L. P. *Physical Organic Chemistry.* New York and London: McGraw-Hill, Chapter VII (1940).
2. JONES, B., and ROBINSON, J. *Nature,* **165**, 453 (1950) and references cited there.
3. ROBERTS, J. D., and YANCEY, J. A. *J. Am. Chem. Soc.,* **73**, 1011 (1951); SHORTER, J., and STUBBS, F. J. *J. Chem. Soc.,* 1180 (1949); JAFFÉ, H. H., FREEDMAN, L. D., and DOAK, G. O., unpublished results.
4. STUBBS, F. J., and HINSHELWOOD, C. *J. Chem. Soc.,* S71 (1949).
5. JONES, B. *Ibid.,* 430 (1943); 267, 358 (1941), and earlier papers.
6. MCCULLOUGH, J. D., and BARSH, M. K. *J. Am. Chem. Soc.,* **71**, 3029 (1949); BROCKMAN, R. W., and PEARSON, D. E. *Ibid.,* **74**, 4128 (1952).
7. WEISSBERGER, A. *Ber.,* **65B**, 1815 (1952); RENFROW, W. B., JR., and HAUSER, C. R. *J. Am. Chem. Soc.,* **59**, 2308 (1937).
8. WALLING, C., and MCELHILL, E. A. *Ibid.,* **73**, 2927 (1951).

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Electrophoretic Behavior of Acid Phosphatase in Human Prostatic Extracts[1]

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In attempting the electrophoretic isolation of acid phosphatase from partially purified extracts of human prostatic tissue we noted that the electrophoretic patterns consistently showed two major protein components in addition to the enzyme. Since scarcely anything is known regarding the properties of the proteins of the prostate, we thought it advisable to present our findings at this time.

Strips of prostatic tissue were extracted overnight at 7° C with 6 ml of 0.85% NaCl per gram (wet weight) of tissue. The extract was dialyzed against distilled water until free of salt, and the insoluble material that appeared with the removal of salt was spun down and discarded. The supernate was lyophilized. A 1–1.5% aqueous solution of the dried powder was fractionated in two steps with $(NH_4)_2SO_4$ at 0° C as follows: The precipitate salted out at half saturation was discarded. The concentration of $(NH_4)_2SO_4$ was increased to two-thirds saturation, and the resulting precipitate was dissolved in a volume of water about two-thirds that of the original solution of powder and dialyzed against running tap water until free of $(NH_4)_2SO_4$. Additional protein was then removed by adjusting the dialyzed solution to pH 4.9 with $N/10$ acetic acid and storing at 0° C for 6 hr. The resulting precipitate was spun down and discarded. After a final dialysis against running tap water the supernate was dried from the frozen state. A white powder resulted.

[1] This work was aided by a research grant from the National Cancer Institute, National Institutes of Health, USPHS, Bethesda, Maryland.

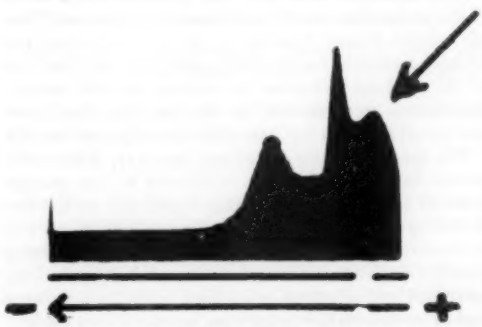
Electrophoretic analysis was carried out in the 2-ml cell of a Perkin-Elmer-Tiselius apparatus, Model 38. Patterns were obtained by both the Philpot-Svensson technique and the schlieren scanning technique, the latter being used for measurements of mobilities.

Mobilities were determined at intervals from pH 4.05 to pH 7.65 at an ionic strength of 0.05 and protein concentrations of approximately 0.75 and 1.5%. Acetate buffers, as reported by Boyd (*1*), were used for the acid range. The Gomori tris(hydroxymethyl)-aminomethane buffer (*2*) was used at pH 7.65, ionic strength 0.05. To make this buffer, 50 ml of 1 *N* HCl were added to 65.4 ml of 0.98 *M* tris(hydroxymethyl)-aminomethane solution, and the mixture made up to 1 liter with distilled water.

At the termination of each electrophoretic run, appropriate fractions were removed from the resolved mixture by means of a needle and syringe and analyzed for phosphatase activity and nitrogen content.

Eight electrophoretic analyses, using five separate extracts, were carried out. Partially purified extracts resolved over a pH range of 4.05–7.65 exhibited three major components. Only one of these seemed to represent prostatic phosphomonoesterase as judged by the activity-nitrogen ratios of the various fractions of the electrophoretically resolved solution withdrawn from the cell. The enzyme was estimated, by measurement of areas under corresponding peaks in the electrophoretic diagrams, to be approximately 10% of the total protein content.

Figure 1 is a representative pattern. The purified extract was obtained from a surgical specimen showing benign hyperplasia. The arrow denotes the component that showed the highest activity-nitrogen ratio; it is therefore assumed to be associated with prostatic phosphomonoesterase. This component has



Acetate buffer; pH 4.60
$\Gamma/2 = 0.1$; conc. = 2.5 mg
N/ml; 113 min

FIG. 1. A cylindrical lens pattern (ascending limb) of partially purified prostatic acid phosphomonoesterase after electrophoresis. (Activity/nitrogen solution before electrophoresis = 86 units/mg nitrogen. Activity/nitrogen of component denoted by arrow = 113 units/mg nitrogen.) (A unit is 1 mg of phosphorus hydrolyzed in 30 min at 37° C from *M*/60 sodium β-glycerophosphate [Eastman Kodak Co.] in acetate buffer at pH 5.5, ionic strength 0.2.)

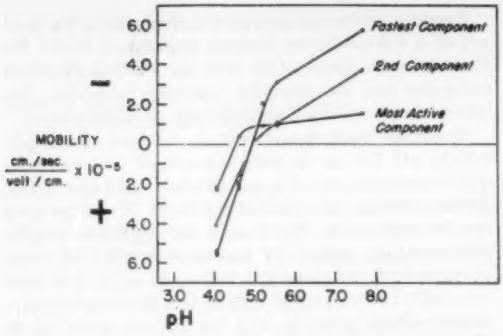


FIG. 2. Variation of electrophoretic mobility (descending limb) with pH of the major components of partially purified prostatic extracts at ionic strength 0.05.

moved toward the anode while the other two components have migrated toward the cathode.

Because of the limited supply of adenocarcinoma of the prostate only one partially purified preparation was analyzed. At pH 5.2 the pattern appeared to be similar to those of preparations from noncancerous prostates.

Figure 2 is a plot of mobility (descending limb) versus pH for the three major components. By interpolation the isoelectric points are as follows: fastest component, between pH 4.9 and pH 5.0; second component, between pH 4.9 and pH 5.0; most active component (acid phosphatase), pH 4.5.

It is of interest that our estimation of pH 4.5 for the isoelectric point of prostatic acid phosphatase is consistent with the value of Kutscher and Pany (*3*), who by the Theorell method of cataphoresis calculated the isoelectric point of purified ejaculate phosphatase to be pH 4.4.

It is apparent that the three proteins share many of the properties usually attributed to albumins. They are soluble in salt-free water and are not salted out by half saturation with $(NH_4)_2SO_4$. In addition two of the proteins remained in solution at their isoelectric points, as evidenced by the fact that they were not precipitated when the pH was adjusted to 4.9.

The electrophoretic mobilities, however, differ sufficiently to permit complete resolution of the components at pH 4.0, a point within 1 pH unit of the isoelectric point of each protein. Since Cohn *et al.* (*4*) emphasize the danger in completely characterizing proteins in terms either of their solubilities in concentrated salt solutions or of their mobilities, without regard to their other properties, no conclusion regarding the chemical nature of the three components is warranted as yet.

References

1. BOYD, W. C. *J. Am. Chem. Soc.*, **67**, 1035 (1945).
2. GOMORI, G. *Proc. Soc. Exptl. Biol. Med.*, **62**, 33 (1946).
3. KUTSCHER, W., and PANY, J. Z. *Physiol. Chem.*, **255**, 169 (1938).
4. COHN, E. J., *et al. J. Am. Chem. Soc.*, **62**, 3386 (1940).

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Adrenal Gland Response to Circulatory Distress in Fetal Lambs

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The fetal heart rate is generally stated to be under the control of the autonomic system (*1*). The present report shows that humoral factors are also operating. During a study of reflex control of heart rate in fetal lambs (110–149 days gestation age), marked cardiac acceleration occurred following asphyxial slowing in 11 instances in which the heart was completely denervated. Experiments were carried out to ascertain the physiological basis of such acceleration.

Grade ewes, made available from the flock of C. W. Williams, Stadacona Farms, Glyndon, Md., were anesthetized with Dial urethane, 0.5 cc/kg given intravenously. The fetus was delivered by Caesarean section. Breathing was prevented by drawing a rubber bag containing amniotic fluid over the nose at the moment of delivery. The placental circulation was maintained intact. The fetus was dried and kept warm by an electric pad. Loose ligatures were placed around the 2 umbilical arteries and veins, to permit occlusion of the vessels at will by applying traction upon the ligatures. Carotid blood pressure was recorded oscillographically by means of a strain gage transducer.

After initial observations on the state of the circulation, the 2 vagi were sectioned in the midcervical region, and the 2 stellate ganglia exposed, dissected free, their branches cut, and the ganglia removed. In addition, the postganglionic fibers from T_3 and T_4 were cut.

Upon occlusion of either the umbilical arteries or veins, bradycardia developed, rapidly when the vagus nerves were intact, and slowly after those nerves were cut. Since about two-thirds of the blood passing down the aorta goes to the placenta (*2*), substantial embarrassment of the fetal heart can be induced by occlusion of the umbilical blood vessels. In 10 of 11 instances in which the heart has been denervated, as described above, restoration of blood flow in the umbilical vessel was associated with a marked tachycardia. In these 10 cases the heart rate increased to 240–276 beats/min. Such high heart rates often were sustained for some minutes.

In order to establish the physiological basis of the cardio-acceleration occurring after circulatory distress in fetuses having denervated hearts, 3 fetuses were subjected to bilateral adrenalectomy. Two experiments were unsuccessful, due to excessive hemorrhage. One was completely successful. Repeated observations were made in this fetus. Some of the data as obtained are summarized in Figs. 1 and 2.

In Fig. 1, occlusion, first of the 2 umbilical arteries and then of the 2 veins, was maintained for 44 and 36 sec respectively (see arrows). Within 12 sec after release of the arteries and 20 sec after release of the

veins, the heart rate started to increase. The rate gained rapidly to 250 and 270 beats/min. The high heart rate persisted in each instance in excess of 230 beats/min for several minutes. The fetus was then bilaterally adrenalectomized, with the results shown in Fig. 2.

After adrenalectomy, occlusion for 44 sec of the umbilical vessels, arteries first, veins next, resulted in a 20-sec delay in onset of recovery after venous occlusion with return to a rate only 9 beats/min in excess of the pre-occlusion rate (204 vs. 195). After arterial occlusion, there was a delay of 66 sec before a rapid recovery set in. The rate then rose to 220 beats/min. This was maintained for a period of about 10 sec. In both cases, the heart rate returned in 3 min to about 200 beats/min. The curve of heart rate decay with complete cord occlusion and no release is indicated by the circles in Fig. 2. The fetus struggled in each instance just prior to the onset of recovery of the heart rate.

This experiment shows that the latent period for onset of recovery of the denervated heart slowed by circulatory distress is prolonged and that the rate of the heart on recovery is less after adrenalectomy than it is before. The conclusion is clear that, in the case of the lamb fetus near term, a supporting physiological mechanism that helps to overcome the effects of acute circulatory distress is the release of a cardiac stimulating agent from the adrenal gland. This could be only epinephrine or a related substance.

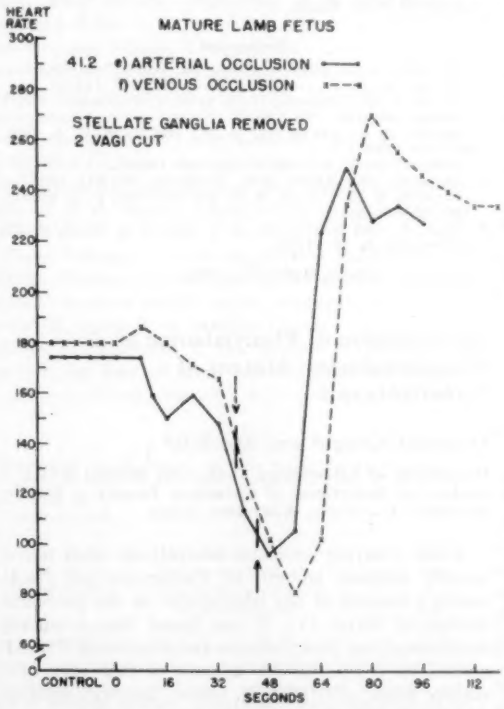

FIG. 1. Curves of heart rate recovery after temporary umbilical artery (——) and vein (x—x) occlusion. Release indicated at arrows. See text for description of prompt and extreme acceleration of heart rate. Mature fetal lamb at term, fetal condition, with 2 vagus nerves and stellate ganglia excised.

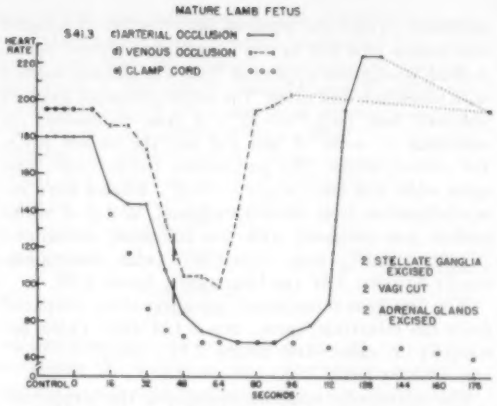

FIG. 2. Same as Fig. 1 except that both adrenal glands were likewise removed. Note long delay in recovery, especially after arterial occlusion, and small increase above pre-occlusion heart rate.

References

1. BARCROFT, SIR J. *Researches into Prenatal Life.* Springfield, Ill.: C C. Thomas (1947).
2. REYNOLDS, S. R. M., *et al. Bull. Johns Hopkins Hosp.*, **91**, 83 (1952).

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Resolution of Isopropyl Nor-Adrenaline into Optical Isomers and Their Pharmacological Potency Ratio

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The resolution into optical isomers of sympathomimetic amines of the type

$$(OH)_2—C_6H_3—CHOH—CH_2—NH—R$$

has been performed for several terms of the series. Among these are epinephrine (*1*) and arterenol (*2*), but it is still an open problem for isopropyl noradrenaline. Since this drug differs markedly from the compounds involved in the sympathetic transmission of nerve impulse (*3, 4*), especially as far as its hemodynamic properties are concerned, it seemed worth while to resolve the racemate into its optical active components and to see if the L isomer would be more potent than the D form, akin to epinephrine and arterenol, or if another condition occurs.

By proper management of solvents and temperatures, the separation succeeded in the following manner: 22.1 g of the racemic base were treated with a solution of 15.5 g D-tartaric acid in 50 ml absolute

methanol. After the product had reacted, the liquid was cooled and left in the ice-box for several hours. A thick precipitate appeared. This was filtered, washed with methanol, and dried. The white-yellowish product obtained had $[\alpha]_D^{20} = +22°$; it was redissolved in methanol at 50–60° C and put into the ice-box again for several hours. The precipitate formed was then quite white and had $[\alpha]_D^{20} = +31.2°$. After a third recrystallization from diluted methanol, 10.2 g of white leaflets was obtained, with the following constants: $[\alpha]_D^{20} = +35.9°$; m.p. = 110–120° (with decomposition); *N* calc.: 3.87 (as bitartrate), found 3.78.

The free base D isopropyl nor-adrenaline, prepared from the bitartrate, gave: m.p. = 164–165° (with decomp.); *N* calc.: 6.66 found 7.07; $[\alpha]_D^{20} = +48.8°$ (as chlorohydrate).

The methanolic solutions containing the levoisomer were dried, the residue dissolved in H_2O, and the free base liberated with NH_4OH. After standing, the crystals were filtered and washed to obtain a white product that showed $[\alpha]_D^{20} = -42°$. They were dissolved in diluted HCl and precipitated again with NH_4OH; 3.6 g of white microcrystalline powder was obtained with the following constants: m.p. = 162–164° (with decomp.); *N* calc.: 6.66 found 7.07; $[\alpha]_D^{20} = -50°$ (as chlorohydrate).

For the pharmacological assays the D isomer as bitartrate, the L isomer as chlorohydrate, and the racemate as sulfate were employed. Equimolecular solutions were prepared and injected intravenously into tracheotomized dogs under light chloralose anesthesia. The vagi were cut and the arterial blood pressure was recorded with mercury manometers.

No tachyphylactic phenomena have been observed; a slight degree of racemization occurs for the solutions of L isomer: 7–12% after 3–5 months. For this reason only fresh solutions were used for the comparison of potency.

The percentage decrease in the blood pressure as a function of the amount administered in micrograms of free base per kilogram body weight has been taken into account for this comparison; furthermore, the duration of the effects observed, i.e., the time required for the blood pressure to revert to its initial value, has also been considered for a better evaluation of potency. This time, in seconds, multiplied by the percentage variation in the blood pressure, yields a quantity *A* (= amount of action) whose log is linearly related to the log dose, as clearly shown by the following regressions:

L isomer: $y = 3.35187 + 0.46124x$; $r = +0.954$; $P < 0.01$
Racemate: $y = 3.26252 + 0.38248x$; $r = +0.952$; $P \simeq 0.01$
D isomer: $y = 0.79125 + 1.16049x$; $r = +0.999$; $P = 0.001$

where $y = \log A$ and $x = \log$ dose.

Deviation from parallelism (shown by the numerical value of the regression coefficient) prevents any comparison of potency, unless the "amount of action," for which the comparison is made, has not been previously fixed. Taking for this amount arbitrary values we obtain:

Potency ratio	log *A*		
	3.0	3.5	4.0
Levo/racemate	1.336	2.095	3.28
Levo/dextro	317.5	87.45	24.6

Since racemates usually are pharmacologically half as potent as one of the optically active isomers (the latter being almost inactive or displaying different properties), the figures of the second row in the table seem to be more reliable.

The optical and pharmacological behaviors of isopropyl nor-adrenaline, as regards the differences between racemate and L isomer, also run quite parallel to those of epinephrine and nor-adrenaline, although the former are pressure-decreasing and the latter are pressure-increasing compounds. The D isomer, on the contrary, appears to be about 90 times less potent than the L isomer, whereas the values which have been put forward for the L/D potency ratio (as regards the blood pressure effects) are 12–15 (*5*) and 15–30 (*6*) for epinephrine; 25–33 (*7*) and 40 (*8*) for nor-adrenaline. These differences probably may be accounted for by differences in the racemization rates of these compounds in body fluids.

References

1. Flächer, F. *Z. physiol. Chem.* **58**, 189 (1908/09).
2. Tullar, B. F. *J. Am. Chem. Soc.* **70**, 2067 (1948).
3. Lands, A. M., Granger, H. R. *et al. J. Pharmacol. Exptl. Therap.* **90**, 110, 254 (1947).
4. Marsh, D. F., Pelletier, M. H., and Ross, C. A. *Ibid.*, **92**, 108 (1948).
5. Cushny, A. R. *J. Physiol.* **33**, 259 (1909).
6. Fromherz, K. *Dtsche med. Wochschr.* **49**, 814 (1923).
7. Tainter, M. L., Tullar, B. F., and Ludueña, F. P. *Science*, **107**, 39 (1948).
8. Holz, P., and Schümann, H. J. Quoted by Holtz, P. *Die Pharmazie*, **5**, 49 (1950).

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Accumulation of Phenylalanine by a Phenylalanineless Mutant of *Escherichia coli*

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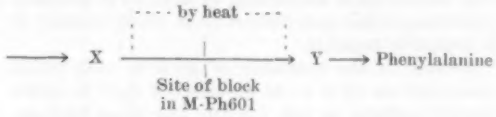
While studying aromatic biosynthesis with nutritionally deficient mutants of *Escherichia coli* (communior) isolated in our laboratories by the penicillin method of Davis (*1*), it was found that a mutant strain requiring phenylalanine for growth (M-Ph601) accumulates a considerable amount of that very substance, when cultivated in Davis' minimal medium (*2*) supplemented with a limited amount of the amino acid. It therefore resembles the similar mutant reported by Simmonds (*3*).

[1] The authors wish to thank Prof. Y. Kuwajima for his continuous encouragements for this study.

Following confirmation of the discovery that a substance that accumulates in the filtrates is responsible for the growth of the mutant, it was still uncertain whether that substance is phenylalanine or its precursor. Decisive evidence that the substance involved is actually phenylalanine was, however, obtained by paper chromatographic analysis of the filtrates together with four other unidentified amino acids (by ninhydrin test). The paper chromatogram showed the presence of phenylalanine. Furthermore, it was confirmed that M-Ph601 responds only to the eluate from the paper bearing the phenylalanine spot.

The conclusion that the phenylalanineless mutant accumulates phenylalanine itself may seem rather strange, since, according to current theory, the mutant exacting for a substance has a genetic block at a certain reaction in the biosynthesis of that substance. We could, however, find a possible explanation for this phenomenon by the following observations. M-Ph601 grown on the minimal medium-agar containing phenylalanine (10 μg/ml) was harvested and thoroughly washed with physiological saline. The washed cells were then suspended in the minimal medium (10^9 cells/ml) and shaken at 37° C. After 1 hr of shaking, the suspension was filtered with a Seitz filter. This filtrate (reinforced with the minimal medium) failed to support the growth of M-Ph601. But the same filtrate, if autoclaved (120° C, 10 min), acquired the ability to support the growth of the mutant.[2] It is obvious that this emergence of the growth-supporting activity is not due to the destruction of an inhibitor by heat, since M-Ph601 was found to be able to grow vigorously in the nonautoclaved Seitz filtrate if phenylalanine was added. Typical results of these shaking experiments are presented in Table 1.

These findings strongly suggest the following possibility. Shaking of the cells of the mutant with the minimal medium results in the accumulation of compound X, which is so unstable that it is readily convertible to compound Y, the product of the blocked reaction, by heat or other factors. Thus the filtrate, if not autoclaved, contains only compound X, substrate of the blocked reaction, and therefore is inactive. After autoclaving, however, compound Y is produced and thus the filtrate acquires the activity. Compound Y may not be phenylalanine itself but is considered to be its precursor, since paper chromatography of the autoclaved filtrate gave no spot corresponding to phenylalanine. These relations can be readily understood from the following scheme:



From these shaking experiments it may be possible to explain the results of the culture experiments as follows. In the culture experiments, too, the accumulation of compound X does take place as the first sequence. But, due to its instability, it is gradually converted to compound Y during the prolonged incubation. Phenylalanine thus produced may then be excreted into medium for reasons unknown as yet.

TABLE 1

RESPONSE OF M-PH601 TO THE SHAKING FILTRATES*

	Filtrate shaken with	Treatment	Growth
1	M-Ph601	Autoclaved	0.31
1a	M-Ph601	Not autoclaved	0.05
1b	M-Ph601	Not autoclaved plus phenylalanine†	0.14
2	Wild type	Autoclaved	0.04
2a	Wild type	Not autoclaved	0.05

* All media were used after reinforcement with 1.5 volumes of minimal medium. Growth was measured after 24 hr of cultivation and expressed in the optical density units at 460 mμ.

† Phenylalanine (3 μg/ml) is added.

[2] With the cells of M-Ph601 harvested from the peptone-bouillon media, no such phenomena were observed.

References

1. DAVIS, B. D. *Proc. Natl. Acad. Sci.*, **35**, 1 (1949).
2. DAVIS, B. D., and MINGIOLI, E. S. *J. Bacteriol.*, **60**, 17 (1950).
3. SIMMONDS, S. *J. Biol. Chem.*, **185**, 755 (1950).

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Autocatalytic Growth of a Mutant Due to Accumulation of an Unstable Phenylalanine Precursor[1]

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Simmonds (*1*) observed that a phenylalanine auxotroph of *E. coli* accumulates a growth factor for itself. In the course of searching for intermediates between shikimic acid (*2*) and phenylalanine we encountered the same phenomenon and concluded, on the basis of paper chromatography with several solvents (using the ninhydrin reaction and bioautography for detection), that at least part of the accumulated active material is phenylalanine. This accumulation was surprising, since mutation-induced growth requirements are generally attributed to loss of activity of a single enzyme, and hence would not be expected to be accompanied by excessive synthesis and excretion of a product of the blocked reaction.

The phenylalanine accumulation became understandable when it was found (*3*) to be preceded by accumulation of an unstable substance, provisionally called prephenylalanine (PPA). The same explanation has been independently arrived at by Katagiri and Sato (*4*), whose manuscript I was privileged to

[1] Aided by a grant from the Rockefeller Foundation.

see. It therefore seemed desirable to present a preliminary report of our work at this time.

PPA has little or no growth-factor activity, either for phenylalanine auxotrophs or for mutants with earlier blocks.[2] Although PPA is stable in alkaline solution, it is very labile to acid; on incubation at 37° C it is converted within a few minutes at pH 2–3, or a few hours at 6.0–6.5, to an active growth factor. This conversion is accelerated by heat. PPA produces a bioautographic spot distinct from phenylalanine; it is ninhydrin-negative.

Because of the instability of PPA to acid, stable accumulations of it could be obtained only in media heavily buffered at pH 7.5–8.0. The usual medium, starting at pH 7.0, became acid enough during cultivation (pH *ca.* 6.5) to account for the conversion of the initially accumulated PPA into an active factor, which in turn could be converted by the cells into phenylalanine.

PPA has been partly purified by charcoal chromatography and its active product has been identified as phenylpyruvic acid. This identification is based on comparison with an authentic sample[3] with respect to the following properties: biological activity, lability to alkali, paper chromatography, $FeCl_3$ color test, ultraviolet absorption spectrum, dinitrophenylhydrazone of m.p. and mixture m.p. 161–163 uncorr. [lit. (*6*) 162–164 corr.]. Attempts to isolate PPA are in progress.

Since the reaction that is blocked in the mutant eventually takes place in the medium, an interesting autocatalytic phenomenon can be observed. When a small amount of phenylalanine is placed on the surface of solid minimal medium heavily seeded with this organism, a circle of growth of the expected diameter appears after one day of incubation. During further incubation, however, this circle spreads until it fills the Petri dish. The organisms growing at a distance from the initial stimulus are genetically unchanged; on reinoculation on minimal medium they fail to grow unless primed with a trace of phenylalanine. Furthermore, if the usual glucose in the medium is replaced by succinate the pH increases rather than decreases during growth, and the area of response to phenylalanine does not spread even though PPA can be shown to accumulate.

The accumulation of phenylalanine by phenylalanine auxotrophs now offers no obstacle to including these mutants in the large class of those that appear to lack a single enzyme.

References

1. Simmonds, S. *J. Biol. Chem.*, **185**, 755 (1950).
2. Davis, B. D. *Ibid.*, **191**, 315 (1951).
3. ———. *Microbial Genetics Bull.*, **7** (Feb., 1953).
4. Katagiri, M., and Sato, R. *Science*, **118**, 250 (1953).
5. Davis, B. D. *J. Bacteriol.*, **64**, 729 (1952).
6. Fones, W. S. *J. Org. Chem.*, **17**, 1534 (1952).

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[2] These mutants with earlier blocks require a mixture of phenylalanine, tyrosine, tryptophan, *p*-aminobenzoic acid, and *p*-hydroxybenzoic acid (*5*). They were used in the presence of all the required factors other than phenylalanine.

[3] Kindly furnished by Dr. Alton Meister.

A Technique for Culturing *Opalina*[1]

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Efforts have been made in the past to culture the protociliates, *Opalina*[2] and *Cepedea*. Pütter (*1*), Konsuloff (*2*), Larson (*3*), Larson and Allen (*4*), and Kedrowsky (*5*) cultured opalinids in complex media with varied success. Recently, Lwoff and Valenteni (*6*) tried to culture *Cepedea* in a complex but bacteria-free medium. In some instances, they were able to continue the culture for 26 days, but they were not certain of the absence of bacteria.

The object of our experiments was to find a method by which opalinids could be maintained continuously in stock cultures. It was thought that the use of such cultures might facilitate life cycle studies and the search for a simplified medium.

A modified Boeck and Drbohlav medium (*7*) for the culture of *Entamoeba histolytica* was used. It was composed of two portions, a solid egg slant and a liquid overlay.

The solid egg slant. Two whole eggs were mixed with 25 ml of distilled water. Two-milliliter portions of this mixture were put into each of a series of test tubes (15 × 125 mm). With the tubes in a slanted position, the egg mixture was coagulated in a water bath at 80° C. *The overlay.* The solid egg slant was covered by a layer of buffered saline solution of the following composition: NaCl, 4 g; $Na_2HPO_4 \cdot 7H_2O$, 2 g; KH_2PO_4, 0.3 g; KCl, 0.2 g; $CaCl_2$, 0.02 g; $MgSO_4$, trace; $NaHCO_3$, 0.4 g; and enough distilled water to make 1 l. The overlay had a pH of approximately 7.8, apparently optimal for culturing these opalinids. Three milliliters of this solution were added to each test tube containing a coagulated egg slant, and the tubes were then plugged with cotton and autoclaved.

To get our initial inoculum, we removed the contents of the rectum of a toad, *Bufo valliceps*, and placed them in a Petri dish containing some of the buffered saline solution. This inoculum contained opalinids, bacteria, and a species of *Entamoeba*. To each culture tube, 0.2 ml inactivated human serum was added and thoroughly mixed with the liquid overlay. To each tube, bacitracin (5 γ), or penicillin G sodium (2000 units), or dihydrostreptomycin sulfate (20 mg) was also added. To each tube, 0.1 ml of the inoculum containing the opalinids and the accompanying organisms was then added and the tubes were kept at room temperature.

After 48, 72, or 96 hr, 0.2 ml of the culture from the bottom of the tube was transferred with a sterile pipet to a new culture tube, similar in all respects

[1] The authors wish to acknowledge valuable suggestions from T. T. Chen and J. L. Mohr of the Zoology Department and Miss F. Hallman of the Department of Microbiology, School of Medicine, University of Southern California.

[2] The *Opalina* used in the experiments was obtained from the rectum of *Bufo valliceps* collected in Louisiana. The species has not been identified.

to the initial culture tubes. The period at which the transfer was made depended upon the abundance of opalinids in the culture. Subsequent transfers were made as required to keep the culture going. If bacterial growth was excessive, a combination of antibiotics (dihydrostreptomycin sulfate and penicillin G sodium) was added at the time of transfer.

Opalinids isolated from a single toad have been cultured continuously since Dec. 10, 1952. At the time of writing, March 30, 1953, they were still in abundant culture. The number and uniform size of the opalinids in all cultures indicated active multiplication and growth. Dividing forms have been observed. Attempts to start a culture with one or a few opalinids have not been successful. In some tubes, entamoebae were rather abundant. Control of bacterial growth with the above-mentioned antibiotics was, in most cases, satisfactory. If bacterial growth was very heavy, simultaneous or alternate use of two antibiotics was more satisfactory than the use of one alone.

References

1. PÜTTER, A. *Z. allgem. Physiol.*, **5**, 566 (1905).
2. KONSULOFF, S. *Arch. Protistenk.*, **44**, 285 (1922).
3. LARSON, M. *Trans. Am. Microscop. Soc.*, **47**, 1 (1928).
4. ———, and ALLEN, F. *Univ. Kansas Sci. Bull.*, **18**, 485 (1928).
5. KEDROWSKY, B. *Protoplasma*, **14**, 192 (1931).
6. LWOFF, A., and VALENTENI, S. *Ann. Inst. Pasteur.*, **75**, 1 (1948).
7. BOECK, W., and DRBOHLAV, J. *Am. J. Hyg.*, **5**, 371 (1925).

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Phosphorylation of 3-Methylglucose by Hexokinase from Rat's Intestinal Mucosa[1, 2]

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It is now a well-established fact that galactose, glucose, and fructose are more rapidly absorbed from the intestine than are other monosaccharides and that in the selective absorption of these sugars some enzymic processes must be involved besides the simple physical process of diffusion. Verzár and his colleagues (*1*) proposed the theory that the selective absorption is connected with phosphorylation of the particular sugars in the intestinal mucosa. This theory was supported by the finding that the amount of hexose phosphate esters in the mucosal cells increases considerably during the absorption of galactose, glucose, and fructose (*2*). It was found, moreover, that homogenates of rat intestinal mucosa phosphorylate galactose, glucose, and fructose *in vitro* in the presence of adenosinetriphosphate (ATP) (*3*). In the latter experiments there was a fair agreement between the rate of phosphorylation of these sugars *in vitro* and the rate of absorption *in vivo*.

[1] Supported by a research grant from the U.S. Public Health Service.

[2] The valuable technical assistance of Jane H. Humm is gratefully acknowledged.

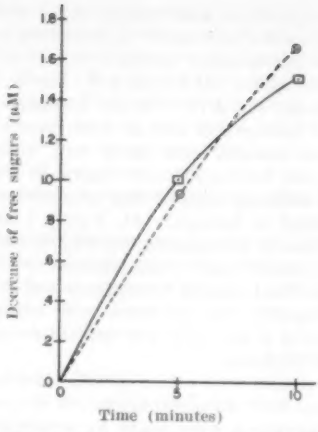

FIG. 1. Decrease of free glucose (interrupted line) and of 3-methylglucose (solid line) in 1-ml total samples in the presence of intestinal mucosa homogenate and ATP.

The use of the unnatural yet stable methyl ethers of glucose in the study of different aspects of carbohydrate metabolism was suggested several years ago by this author (*4, 5*) and the absorption of 2-, 3-, 5-, and 6-methyl derivatives of glucose from the rat's intestine was studied (*6*). Only 3-methylglucose is absorbed at about the same rate as glucose, whereas the blocking of the carbon atoms 2, 5, or 6 completely abolishes the selective absorption. This finding seemed to support the phosphorylation theory and emphasized the possibility of an aldose-ketose transformation during the absorption to yield phosphofructofuranoses.

The absorption of 3-methylglucose from the intestine of rats and cats was studied later in another laboratory with similar results (*7*). From the latter experiments the conclusion was drawn that phosphorylation cannot play an important role in the selective absorption of glucose. This conclusion was based on the finding that 3-methylglucose is not glycogenic in rats and thus "almost certainly not phosphorylated *in vivo*" (*8*). No direct experimental evidence was presented, however, to demonstrate the failure of the intestinal mucosa to phosphorylate 3-methylglucose.

In the course of further study of the metabolism of glucose methyl ethers, it was found recently in this laboratory that the amount of free reducing sugars decreases in the case of both glucose and 3-methylglucose if incubated with rat's intestinal mucosa homogenate and ATP *in vitro*. No decrease of such nature is noticeable if ATP is omitted from the mixture. This is strong presumptive evidence that the disappearance of free reducing sugars is due to phosphorylation by hexokinase. The following experimental procedure was used. White rats were sacrificed by decapitation and the intestinal mucosa was scraped off and homogenized with 2 ml of ice-cold distilled water. In small open Pyrex test tubes, mixtures containing

0.5 ml homogenate in total volume of 1.0 ml were incubated in a water bath at 30° C. Each tube contained besides the homogenate: tris(hydroxymethyl)-aminomethane-HCl buffer pH 8.0, 0.10 *M*; $MgCl_2$, 0.01 *M*; sugar, 0.01 *M*; and ATP, 0.03 *M*. Immediately after addition of homogenate and at short intervals thereafter 0.1-ml samples were taken and treated with $Ba(OH)_2$ and $ZnSO_4$ and centrifuged. In the supernatant the reducing capacity was measured according to the method of Somogyi (*9*). Figure 1 shows the rapid decrease of the reducing capacity in the samples containing glucose and 3-methylglucose in the presence of intestinal mucosa homogenate and ATP. The reducing capacity did not decrease in either of the sugars studied if the ATP was omitted from the experimental mixtures.

Similar results were obtained with soluble enzyme preparations from intestinal mucosa of rats and dogs. These preparations were made by scraping off the mucosa and freezing immediately with liquid air and pulverizing in a mortar. The powder while frozen was treated several times with cold (below −10° C) acetone, thereafter with ether, and dried in air. This acetone dry powder could be kept at temperatures below −10° C for 10–14 days without loss of activity. Soluble preparations were made by stirring the dry powder with ice-cold distilled water and centrifuging. The clear supernatant loses activity if stored more than 48 hr, even at temperatures below −10° C.

References

1. Verzár, F., and McDougall, E. F. *Absorption from the Intestine.* London: Longmans, Green (1936).
2. Kjerulf-Jersen, K. *Acta Physiol. Scand.*, **4**, 225 (1942).
3. Hele, M. P. *Nature*, **166**, 787 (1950).
4. Csáky, T. Z. *Ber. ges. Physiol.*, **94**, 662 (1936).
5. Csáky, T. Z., and Sass-Kortsák, E. *Ibid.*, **131**, 227 (1942).
6. Csáky, T. Z. *Z. physiol. Chem.*, **277**, 47 (1942).
7. Campbell, P. N., and Davson, H. *Biochem. J.*, **43**, 426 (1948).
8. Davson, H. *A Textbook of General Physiology.* London: J. & A. Churchill, p. 303 (1951).
9. Somogyi, M. *J. Biol. Chem.*, **160**, 61 (1945).

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Comments and Communications

The Tension Concept in Aquatic Biology

Students of animal respiration have long used the tension concept to express the pressure of O_2 or CO_2 in body fluids. (Tension = partial pressure of O_2 or CO_2 in the gas phase at equilibrium between gas and liquid phases.) For terrestrial animals the concept is realistic and valuable because an exchange of gases between gas and liquid phases is essential to the respiration process. But in aquatic animals, where movement of CO_2 and O_2 is confined to the liquid phase, the tension concept is superfluous and even misleading. It is superfluous because the O_2 and CO_2 contents of the environment can be measured directly, and misleading because it leaves the erroneous impression that exchange of dissolved gases between animal and environment is similar to the exchange between gas and liquid phases. When respiration in aquatic environments is studied at constant temperature, the relation between tension and concentration is a constant one, and no serious ambiguity results; but when temperature varies, the tension-concentration relationship, of course, varies greatly as a result of changing solubilities of O_2 and CO_2.

These facts are well known, but their importance has not always been evaluated carefully. An example of such failure appears on pages 242–243 of *Comparative Animal Physiology* (Prosser, Brown, Bishop, Jahn and Wullf [Saunders, 1950]) where, in Fig. 53, a graph of Fry and Hart (The relation of temperature to oxygen consumption in the goldfish, *Biol. Bull.*, 94, 66–77 [1948]) is reproduced. The graph shows the relation between oxygen tension and consumption in a goldfish exposed to temperatures varying between 5° and 35° C. From this graph Prosser *et al.* draw the conclusion: "At reduced tensions the oxygen consumption rapidly falls off, being affected at a higher oxygen tension for the higher metabolic rate, indicating the inability of the fish to maintain the specific activity at the designated temperature." But if this graph is reconstructed using concentrations, i.e., oxygen in solution, instead of tensions, the trend practically disappears, and the critical oxygen concentration proves to be about 60 μmol per liter regardless of temperature (or the fish's activity). The relative constancy of this critical oxygen concentration indicates that diffusion across the gill membranes was not an important limiting factor in O_2-uptake during those experiments—a significant implication of the data which Prosser *et al.* have missed while discussing a trend which was primarily an artifact of changing solubility.

The text goes on to say that one should not ignore the changing solubility of oxygen, and the increase in activity, with temperature. But no evaluation of these factors is made. One is left with the impression that these variables cannot be isolated. The authors could profitably have turned back to pages 210–211, where they reproduce Fick's law, and where they discuss the influence of temperature on the "diffusion constant." Fick's law employs concentrations, not tensions, thus the influence of solubility is taken into consideration simply by determining the concentration. The influence of temperature on the diffusivity or "diffusion constant" can also be estimated (about 1% per degree near 20° C) so the product Concentration × Diffusivity provides an expression of oxygen

availability which identifies the quantities and forces that operate.

Further inspection of Fick's law reveals that the change in diffusivity with temperature is only partly (about 0.3% per degree near 20° C) explained by the proportionality with absolute temperature (T). The major influence must be associated with changes in frictional resistance (f) of the medium with temperature.

The above comments will serve to emphasize that the tension concept is not useful when one is concerned with diffusion within the liquid phase. Concentration units should be used in such situations, and if one wishes to account for changes in diffusivity the product Concentration × Diffusivity will provide the desired index.

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Received December 1, 1952.

Treatment of Mouse-Passaged Dengue Virus (Mochizuki-strain) with Protamine Sulfate

IT has been reported that certain viruses are precipitated by adding protamine sulfate to the crude suspensions (*1–3*), and that many species of virus fall into two groups, with few exceptions, i.e., those protamine-precipitated, of larger size, and those protamine-non-precipitated, of smaller size (*3*). Nakagawa (*4*) reported his results of the application of protamine to the Hawaiian strain dengue virus isolated by Sabin and Schlesinger (*5*). The author also, independently of Nakagawa, conducted experiments on the protamine treatment of the mouse-passaged Mochizuki-strain dengue virus (*6*).

From mice moribund after an intracerebral infection of dengue virus, the brains were removed and ground into a 20% emulsion with distilled water.[1] The emulsion was centrifuged at 3,000 rpm for 15 min, and the supernatant fluid taken out was the original virus suspension. Protamine sulfate (elupeine, powdered)[2] was added to the virus suspension at the ratio of 5 mg/ml. The mixture, containing flocculates formed, was set at 0° C for 24 hr, then centrifuged at 3,000 rpm for 60 min. The supernatant thus obtained was slightly opaque fluid. Virus concentrations of the original suspensions as well as the supernatant were measured by an ordinary ten-fold titration in mouse brain. Additionally, the nitrogen amounts of these materials were determined by the micro-Kjehldahl method.

TABLE 1

VIRAL CONCENTRATIONS AND NITROGEN AMOUNTS OF PROTAMINE-TREATED MATERIALS

Expt. No.	Crude suspensions		Protamine supernatants	
	LD50* (Log)	Nitrogen (mg/ml)	LD50* (Log)	Nitrogen† (mg/ml)
I	5.7	1.512	5.7	1.028
II	6.0	1.538	5.9	1.176
III	6.0	1.521	6.0	1.085

* By the Reed-Muench method (*7*).
† Containing the excess of protamine.

[1] Adjusted to be pH 7.0 with sodium bicarbonate.
[2] Prepared by the Kossel method at Kyoto University Department of Biochemistry.

Results obtained are summarized in Table 1, and indicate that (1) dengue virus remains abundantly in the protamine-supernatants, (2) therefore, it can be included in the Warren's "protamine-non-precipitated" group of viruses (*3*).

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References

1. BAWDEN, F. C., and PIRIE, N. W. *Proc. Roy. Soc.*, B, **123**, 274 (1937).
2. CHAMBERS, L. A., and HENLE, W. *Proc. Soc. Exp. Biol. Med.*, **48**, 481 (1941).
3. WARREN, J. *Bacteriol. Rev.*, **14**, 200 (1950).
4. NAKAGAWA, Y. Personal communication.
5. SABIN, A. B., and SCHLESINGER, R. W. *Science*, **101**, 640 (1945).
6. HOTTA, S. J. *J. Infectious Diseases*, **90**, 1 (1952).
7. REED, L. J., and MUENCH, H. *Am. J. Hyg.*, **27**, 493 (1938).

[3] The author wishes to express his gratitude to Professor Ren Kimura, director of the Institute, for helpful advice in the experimentation. He is also indebted to Mr. Atsushi Sugii and Miss Miyo Sasaki for their technical assistance.

Received January 30, 1953.

Evidence for the Nonexistence of a New Highly Penetrating Component of the Solar Radiation

IN 1941, M. Takata and T. Murasugi (*Bioklim. Beiblätter der Meteorologischen Zeitschrift*, **8**, 17–26, [1941]) had described a very surprising discovery. These Japanese authors had found that the amount of $HgCl_2$ solution which has to be added to produce protein flocculation in diluted human blood serum varies approximately 10 to 15% dependent upon whether the blood, from which the serum is prepared, is taken from the vein some minutes before or some minutes after the sunrise. It was particularly interesting that this effect (called by Takata the "cosmoterrestrical effect") is noted only if the person is electrically insulated from ground during the taking of blood. Furthermore, the effect is also present in the same intensity, if the person is in a deep cellar room protected from any solar radiation by thick layers of earth and concrete. So, it seemed that a very penetrating and, before Takata's work, absolutely unknown component of solar radiation was found for which only the biochemical test of Takata, but no known physical experiment, gave evidence. Because of the highly interesting physical aspect of the findings

of Takata, the experiments of Takata were repeated on a very large scale by the author and his co-workers during the period from autumn 1950 to spring 1952. The original Takata technique was considerably improved by the introduction of a new and more sensitive method of detecting the initial flocculation. Conductivity measurements were made instead of visual observation of the appearance of the flocculae, used by Takata. After having eliminated some preliminary sources of error, no "cosmoterrestrical Takata effect" could be found at all in more than 100 sunrise experiments despite the fact that decidedly more sensitive measurements were made than had been made by Takata. Also another effect described by Takata, the influence of electrically charging the person from whom the blood was to be taken on the protein liability, could in no way be verified, although, once again the sensitivity of measurement was higher than in Takata's experiments. Other properties of the human blood were experimentally investigated; namely, the pH value of the streaming blood, the blood cell sedimentation constant, the prothrombin amount of the blood and the albumin/globulin ratio of the blood (by electrophoresis). In no experiment was it possible to detect, in even the slightest degree, an effect of the sunrise. Finally, an experiment was performed to determine whether a slight change in the electrical charge of an insluated human being could be detected, by direct electrical measurements, during the sunrise. No such effect was present. All these experiments, performed with high precision, having produced only negative results so far as the effect of sunrise is concerned, support the conclusion that the "cosmoterrestrical Takata effect" is not present at all. The results of Takata and Murasugi were caused by either systematic errors or psychological illusions involved in the original, rather inaccurate, technique of Takata.

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CORRECTION: In the paper by Evans that appeared on page 718, SCIENCE, June 26, the spelling of "Bromsulfalein" should be corrected to read "Bromosulfalein," which is the chemical name of a dye that can also be obtained commercially under the capitalized trade-mark "Bromsulphalein." Correct identification of the substance is important in all discussions of its use, including the recent one.

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Book Reviews

Crime Investigation: Physical Evidence and the Police Laboratory. Paul L. Kirk. New York–London: Interscience, 1953. 784 pp. Illus. $10.00.

Dr. Kirk's avowed intention that this book should serve the "needs of police investigators, general criminalists in the small police laboratories, and students of criminalistics and police science" appears to be too broad. The needs of these groups are not identical or even nearly so. The police investigator is by far the largest of the three groups and is in itself a "specialty" not closely allied to the worker in the small laboratory or the student.

It is not believed that the book has strong appeal for the investigator whose requirements are best served by acquainting him with the possibilities that scientific evidence has to offer. It may be assumed that a more detailed listing of the scientific possibilities never hurts him, but it should be noted that memory is a fickle matter and people tend to remember "wholes" in reference to parts. Too much emphasis on the "parts" in learning often results in a lack of recognition of the "wholes." This, in my opinion, is the error of this book as applied to the "needs of the investigator."

There are many statements that will meet with disagreement by other workers in the field. Such statements and, in some cases, implications might lead the reader to believe that the uncommon becomes the routine. The author states that

> From an examination of a glove found at the scene, the following inferences were drawn: (a) The culprit was a laborer associated with building construction. (b) His main occupation was pushing a wheelbarrow. (c) He lived outside the town proper on a small farm or garden plot. (d) He was a southern European. (e) He raised chickens and kept a cow or horse.

The untrained reader may conclude from the above that such inferential reasoning should persist in all cases, and when the police laboratory fails to provide a full description of the criminal in all instances, regardless of the evidence submitted, confidence in scientific crime investigation falters. In criminal investigation, the identification and examination of blood stains is important but usually difficult because of contamination and other factors. Yet the author suggests that "Examination of blood stains may yield information on the presence or absence of syphilis in the donor." Inclusion of the phrase "in the donor" implies fresh liquid blood. The determination of syphilis in fresh blood specimens is a routine examination, but since the heading is "Blood Stains," we presume the author implies that syphilis can be detected from an examination of the stain. Serologists with whom I have discussed the feasibility of testing blood stains for syphilitic bodies hold no claim for positive accuracy. In this procedure, in fact, they all advise against such examinations.

Such points of controversy can be easily recognized

by the specialist, but those not specialized will labor under misapprehension until they learn by experience.

The worker in the small laboratory and the student may well profit from the treatment given in this book to the wide variety of scientific methods that may be applied in criminal work. These groups, however, will have the time necessary to evaluate the suggested techniques and recognize the limitations inherent in such instances, such as the educational background necessary and the amount of practical experience required to arrive at the logical conclusion in a given method.

Persons more experienced and more learned in the field of scientific criminal investigation will take a more kindly view of this book. Such must be the case as evidenced by the fact that New York University Graduate School of Public Administration and Social Service conducted an institute on "Modern Methods in Law Enforcement" on August 3–7, and selected this book as the textbook for the course.

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Marine Fouling and Its Prevention. Prepared for the Bureau of Ships, Navy Department, by the Woods Hole Oceanographic Institution. Annapolis, Md: U. S. Naval Institute, 1952. 388 pp. Illus. $10.00.

This compilation is the outgrowth of the fouling investigations conducted by the Woods Hole Oceanographic Institution during the years 1940–46. It is both an introduction to an important aspect of marine ecology and a manual of antifouling techniques and materials.

Most of the book is designed for the use of naval and shipping interests, and the biological discussions are intentionally elementary, to be consulted by laymen, with one important exception. This is Chapter 10, "intended for the professional biologist and may have little interest to others." Although the professional biologist will consider most of the introductory chapters excellent essays in what might be called semi-popularization, this chapter intended for him has some serious defects. The key to the chapter is its 30-page appendix, a "list of species recorded from fouling." It appears to be a first approximation in several respects; eight categories, for example, have been compiled from single references and half a dozen more from only two or three sources. Granted that most of the categories so treated are groups of minor importance, nevertheless this list is used as the basis for several tables summarizing the distribution and types of organisms involved in fouling. Another defect of this master list is that several important groups are composed in large part of species drawn from unpublished sources and in several cases the determinations were made by individuals without published papers in these systematic groups. In almost every group, a specialist may be able to offer additional species overlooked by the compiler of this list or point out duplications. This is extreme in the case of the anemones, where 12 species and varieties are listed although there are only 5 fully recognizable species (5 of the names are easily equated to 2 species by inspection). Nevertheless the 12 different names are carried into the summary tables as full species.

For the biologist, at least, one of the most useful chapters in this book is Chapter 5, "The Seasonal Sequence," summarizing by graphs the temperatures, periods of settling, and quantitative aspects of fouling in various parts of the world. The second half of the book is given over to methods of fouling prevention and control, starting with a short history of the subject and including a list of British, German and U. S. patents issued for antifouling compounds and devices. The emphasis throughout this section is on the protection of surfaces; the most adequate discussion of fouling control in salt water systems is to be found in the first chapter. The use of double systems in industrial plants or aquaria is not mentioned.

The book is well printed and illustrated; the large page size makes the volume comparable to an ordinary octavo of perhaps more than 500 pages.

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Wood Chemistry, Vols. 1 and 2. 2nd ed. American Chemical Society Monograph Series. Louis E. Wise and Edwin C. Jahn, Eds. New York: Reinhold, 1952. Vol. 1, 688 pp., illus.; Vol. 2, 652 pp., illus. $15.00 the volume.

General interest in wood chemistry has grown rapidly in recent years because of increased demands for wood pulp and because of greater fundamental interest and industrial curiosity regarding the numerous non-cellulose components of wood. For all persons interested in wood chemistry the new edition of *Wood Chemistry* will be of great value. It is a complete and extensive revision of the work first published in 1946. Because of the amount of material presented, the second edition is in two volumes.

Volume I is divided into three parts, each with its complement of chapters written by established research men. Part I, "Growth, Anatomy and Physical Properties of Wood" contains chapters by H. P. Brown and C. C. Forsaith. Here is described the general morphology of soft and hard woods from the biological viewpoint, but with notations as to the location of chemical compounds. Tensile and compressive strengths of woods are treated in relation to such factors as structure, moisture, and the presence of the various chemical substances.

Part II, "Components and Chemistry of the Cell Wall" contains chapters by W. M. Harlow, L. E. Wise, H. Mark, C. B. Purves, A. J. Stamm, E. C. Jahn, and F. E. Brauns. This part deals with the chemical composition of wood cells and middle lamella, and the physical and chemically modified

cellulose is exclusively treated with particular emphasis upon oxidation, hydrolysis, esterification, and solubility. The hemicelluloses are discussed from the standpoint of occurrence, preparation, and composition. An extensive review of lignin chemistry is also given.

Part III, "The Extraneous Substances" contains chapters by L. E. Wise, E. F. Kurth, G. C. Harris, M. A. Buchanan, and H. Erdtman. This section deals principally with wood substances extracted with neutral organic solvents. It contains a detailed description of the voluble oils (essential or ethereal), wood resins, tannins, coloring material, and other less easily classified extractives of wood. There is also an interesting discussion of the coniferous extractives in relation to taxonomy.

Volume II is divided into four parts. Part IV, "Surface Properties of Cellulose Materials" is a chapter by A. J. Stamm that discusses such factors as adsorption of gases including water vapor, selective adsorption from solution, dimensional changes resulting from sorption, thermodynamic changes, specific volume, mechanical properties, electrical properties, capillary structure, and chemical treatment of wood.

Part V, "Industrial Wood Chemistry" contains chapters by L. F. Hawley, A. W. Goos, E. E. Harris, E. C. Jahn, W. F. Holzer, Holger Erdtman, and F. H. Yorston. The combustion of wood, its thermal decomposition, hydrolysis, chemical behavior, delignification and bleaching are discussed.

Part VI, "Decomposition of Wood by Microorganisms" consists of a chapter by W. G. Campbell which treats this subject in considerable length.

Part VII, "The Chemical Analysis of Wood" contains six chapters by B. L. Browning and one by Browning and I. H. Isenberg. In this section a lengthy and complete discussion of analytical methods is presented in usable form.

These new volumes contain a vast amount of information and extensive literature references. At several points, so many references are presented that the text becomes a series of brief uncritical abstracts of the literature. On the whole, the text is well wirtten and critically presented. Very few proofreaders' errors were noted. The reviewer was impressed by the extensive and complete treatment given to most subjects. The volumes will prove of great value to everyone interested in the components of wood. Although written primarily for the chemist, the biologist will also find much valuable information.

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Scientific Book Register

Acanthocephala of North American Mammals. Illinois Biological Monographs, Vol. XXIII, Nos. 1–2. Harley J. Van Cleave. Urbana: Univ. Illinois Press, 1953. 179 pp. Illus. $5.00; $4.00 paperbound.

The Study of Human Nature. David Lindsay Watson. Yellow Springs, Ohio: Antioch Press, 1953. 262 pp. $3.50.

Groups in Harmony and Tension: An Integration of Studies on Intergroup Relations. Muzafer Sherif and Carolyn W. Sherif. New York: Harper, 1953. 316 pp. + plates. $3.50.

Our Neighbour Worlds. V. A. Firsoff. New York: Philosophical Library, 1953. 336 pp. Illus. + plates. $6.00.

Basic Mechanics of Fluids. Hunter Rouse and J. W. Howe. New York: Wiley; London: Chapman & Hall, 1953. 245 pp. Illus. $4.50.

Explorations in Science. Waldemar Kaempffert. New York: Viking Press, 1953. 296 pp. $3.50.

A Herd of Mule Deer. A record of observations made on the Hastings Natural History Reservation. Jean M. Linsdale and P. Quentin Tomich. Berkeley: Univ. Calif. Press, 1953. 567 pp. Illus. $8.50.

Mr Tompkins Learns the Facts of Life. George Gamow. New York: Cambridge Univ. Press, 1953. 88 pp. Illus. $2.75.

Progress in Biophysics and Biophysical Chemistry, Vol. III. J. A. V. Butler and J. T. Randall, Eds. New York: Academic Press, 1953. 386 pp. Illus. + plates. $9.50.

Tables for Rocket and Comet Orbits. National Bureau of Standards, Applied Mathematics Series 20. Samuel Herrick. Washington, D.C.: Government Printing Office, 1953. 100 pp. $1.75.

Endosymbiose der Tiere mit Pflanzlichen Mikroorganismen. Reihe der Experimentellen Biologie, Band 12. Paul Buchner. Basel–Stuttgart: Verlag Birkhäuser, 1953. 771 pp. Illus. Sw. fr. 66.50; paperbound 62.40.

Plant Diseases in Orchard, Nursery and Garden Crops. Ernst Gram and Anna Weber; trans. from 2nd Danish ed. by Evelyn Ramsden, R. W. G. Dennis, Ed. New York: Philosophical Library; London: Macdonald, 1953. 618 pp. Illus. + plates. $18.50.

General Biochemistry. William H. Peterson and Frank M. Strong. New York: Prentice-Hall, 1953. 469 pp. Illus. + plates. $6.50.

Tool Engineers' Data Book. Gerhard J. Gruen. New York: Reinhold, 1953. 219 pp. $5.50.

Our Physical Environment: A Problem Approach. Leonard W. Gaddum and Harold L. Knowles. Boston: Houghton Mifflin, 1953. 625 pp. Illus. $5.50.

Brown Coal: Its Mining and Utilization. A series of postgraduate lectures delivered in the School of Engineering, University of Melbourne. P. L. Henderson, Ed. Melbourne: Melbourne Univ. Press; New York: Cambridge Univ. Press, 1953. 351 pp. Illus. + plates. $7.50.

Studies in Econometric Method. Cowles Commission Monograph #14. W. C. Hood and Tjalling C. Koopmans, Eds. New York: Wiley; London: Chapman & Hall, 1953. 323 pp. $5.50.

Soils and Land of Michigan. J. O. Veatch. East Lansing, Mich.: Michigan State College Press, 1953. 241 pp. Illus. + map. $7.50.

Vorstellungen vom Aufbau der Materie im Wandel der Zeiten. Eine historische Übersicht. Fritz Lieben. Vienna: Franz Deuticke, 1953. 384 pp. $7.20.

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Sept. 3–5. Conference on Problems in Astrometry. Northwestern University and National Science Foundation, Evanston, Ill.

Sept. 4–9. American Psychological Association. Michigan State College, East Lansing, Mich.

Sept. 4–9. Psychometric Society (Annual). Michigan State College, East Lansing, Mich.

Sept. 5–12. International Meeting of Pharmacologists. Montreal, Canada.

Sept. 6–8. American Society for Horticultural Science (50th Anniversary, with AIBS). University of Wisconsin, Madison, Wis.

Sept. 6–10. American Institute of Biological Sciences (Annual). University of Wisconsin, Madison, Wis.

Sept. 6–11. Friends of the Kresge-Hooker Scientific Library (with ACS). Chicago, Ill.

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Sept. 7–11. American Chemical Society. Chicago, Ill.

Sept. 7–12. International Neurological Congress (5th). Lisbon, Portugal.

Sept. 7–12. World Congress for Physical Therapy. London, England.

Sept. 8–11. American Association of Clinical Chemists (5th Annual, with ACA). Chicago, Ill.

Sept. 8–12. European Haematology Congress (4th). Amsterdam, Netherlands.

Sept. 9–11. Conference on Nuclear Engineering. University of California, Berkeley, Calif.

Sept. 9–11. National Agricultural Chemicals Association (20th Anniversary). Spring Lake, N. J.

Sept. 9–15. American Meteorological Society (124th, with Royal Meteorological Society). Toronto, Canada.

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Sept. 12–14. Symposium on the Utilization of Solar Energy. University of Wisconsin, Madison, Wis.

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Sept. 13–24. International Navigation Congress (18th). Rome, Italy.

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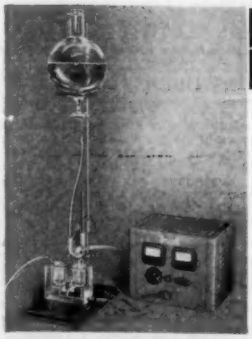

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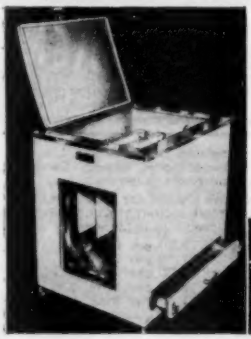

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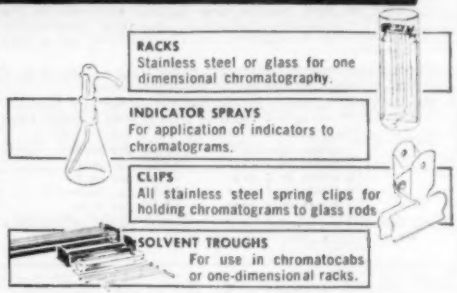

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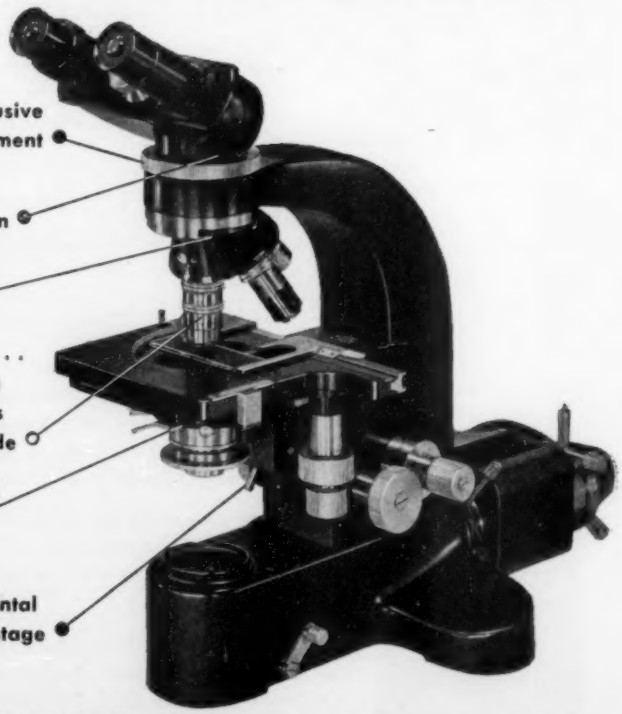

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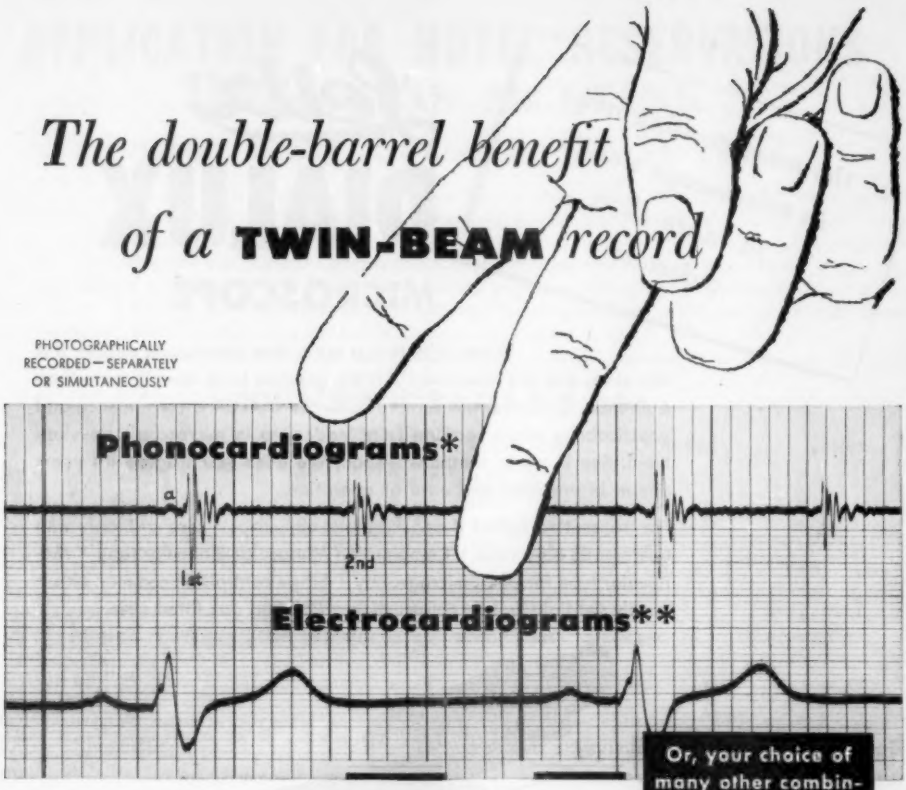

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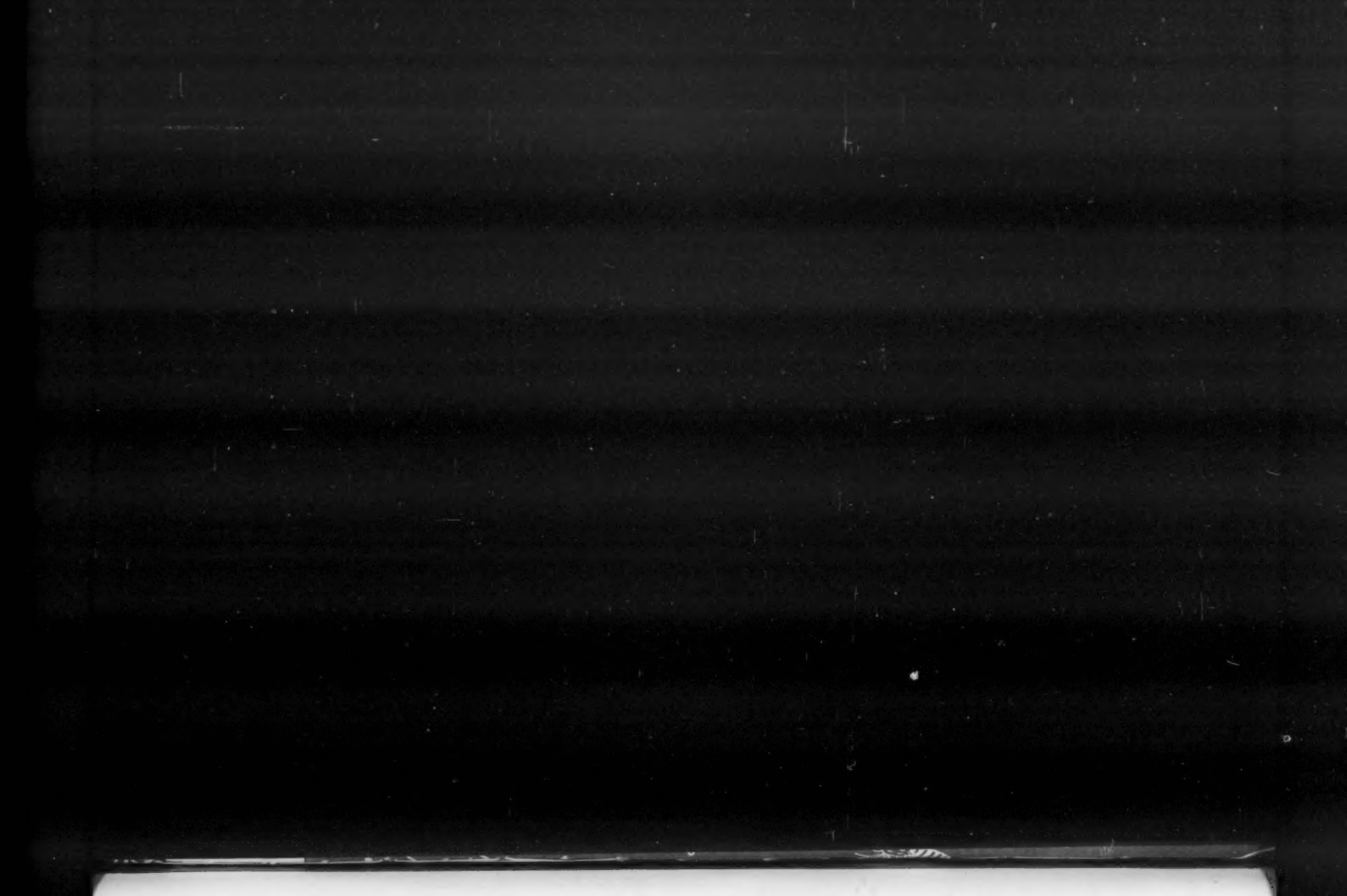
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